D TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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It's St. Louis
in 1956

SIXTEENTH
ANNUAL MEETING
OF IFT

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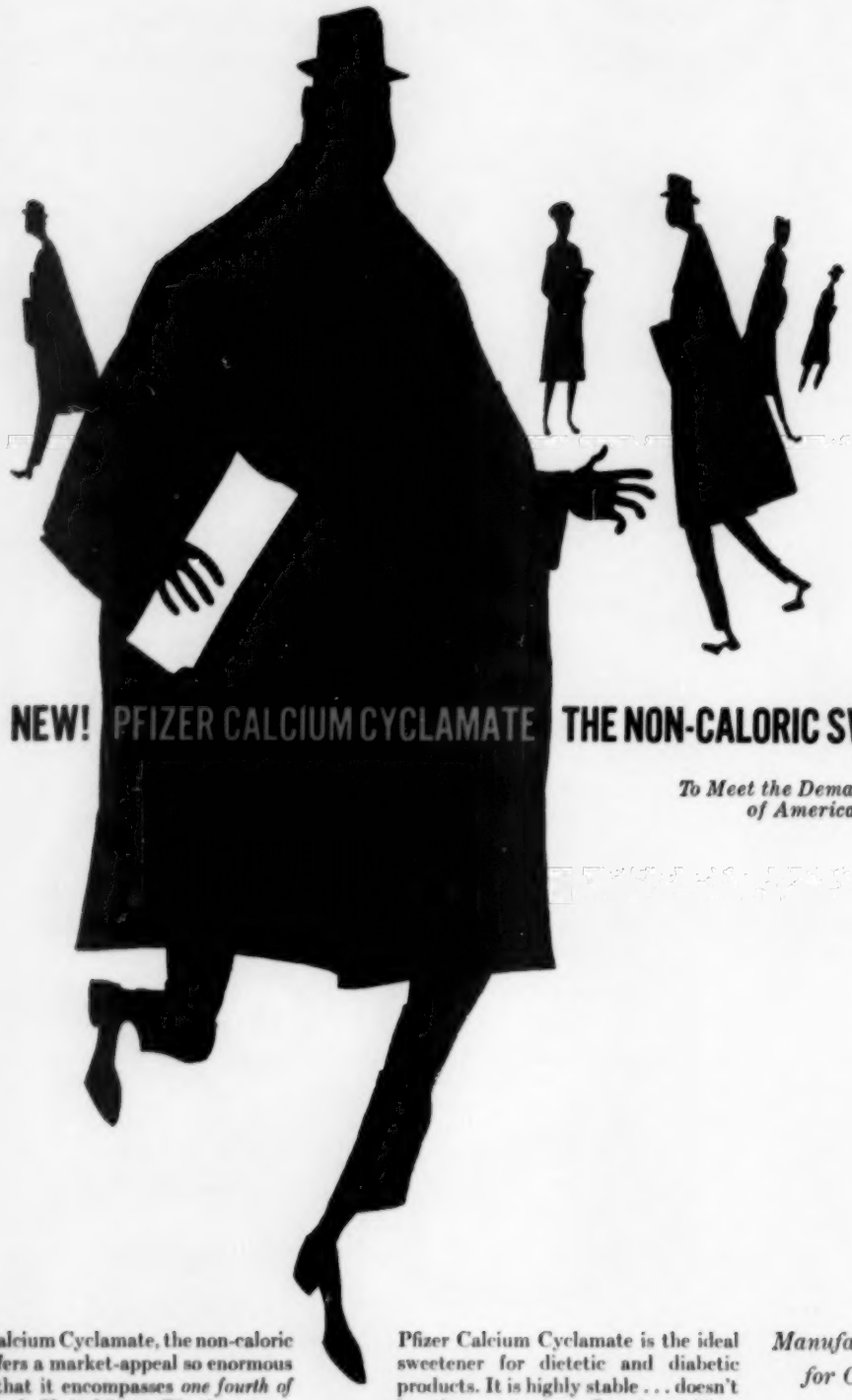
July, 1955 Volume 9, Number 7



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To Meet the Demands of America's "Heavy" Market

New Pfizer Calcium Cyclamate, the non-caloric sweetener, offers a market-appeal so enormous in potential that it encompasses *one fourth of all the adults in the United States!* That's approximately 34,000,000 overweight or diabetic consumers who avoid sugar-sweetened food and drink . . . and may be avoiding yours.

This addition to Pfizer's expanding line of food and beverage ingredients is introduced at a most favorable time. For this *big volume, high profit* dietetic market is now at an all-time high! What an opportunity to "jump in" at exactly the right moment with *your* cyclamate-sweetened food or beverage product!

Pfizer Calcium Cyclamate is the ideal sweetener for dietetic and diabetic products. It is highly stable . . . doesn't lose its sweetening effect in cooking, baking, canning or freezing. It is a safe, pure and sure sweetener, salt-free to meet strictest diet requirements. It does not impart a bitter off-taste or after-taste to your product, and it's compatible with all flavorings.

Look into Pfizer Calcium Cyclamate now. Contact Pfizer for full details, a working sample and counsel on your plans for launching a full scale or test-market product, aimed at those millions who count their calories!

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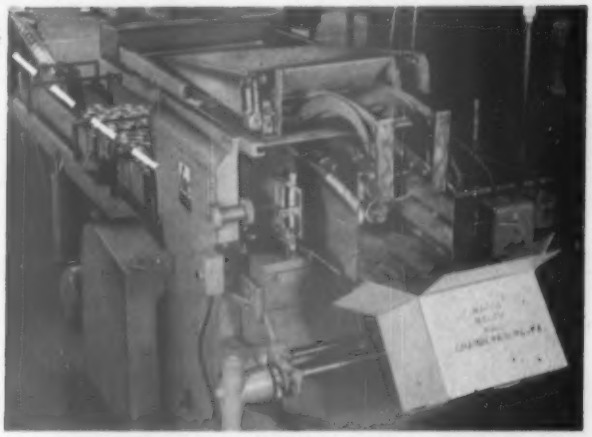
FROM HARVESTING TO CASING



FMC "Stalk to Storage" Corn Equipment Produces a Higher Yield—Delivers a Quality Pack

FMC has virtually grown up with – and in – the corn canning industry, helping it grow through continuous contributions of research and modern equipment development. Many of the industry's achievements – its supremely high standard of quality, its ability to produce in enormous volume – are the direct results of this long and fruitful partnership. Today you'll find FMC *specialized* "Stalk to Storage" corn equipment in every corn canning plant in the country, many of which are completely FMC equipped. And every year you'll find new and improved equipment that has been carefully designed to do specific jobs better, faster, for greater profit for you. Some of this equipment is shown or briefly described here. Your line should also include FMC Fillers, Sterilizers, Labelers and other Can Handling Equipment.

Above: **The FMC SWEET CORN HARVESTER** *gets all the corn in the field, produces corn for canners, freezers, even for the cob-corn market! It replaces a hand-picking crew of 10 and at greater yield.*

Below: **FMC's NON-SHOCK CASER** *automatically cases cans fast (up to 1,200 cases per hr.)—limited only by the speed of the operator. It's gentle to cans, labels and products, cuts costs.*

OTHER FMC CORN HANDLING EQUIPMENT

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- **FMC DOUBLE HUSKER** cleanly trims butts and strips husks at 2½ tons of corn an hour. Unequalled for efficiency!
- **FMC EAR CORN SILK BRUSHER,** with its brushes spinning at high speed, washes and scrubs every row of kernels of every ear, removing all silk. The larger handles output of 20 FMC Huskers; the smaller, that of 8 Huskers.
- **FMC UNIVERSAL ROTARY CORN CUTTER**—a key machine in any corn line for maximum recovery of kernels from the cob, for cream style or whole grain packs. Up to 120 ears per minute depending on operator's skill.
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Affairs of the Institute

Dr. Clifcorn Takes Office as IFT President
Regional News
Personnel
Masters and Doctors in Food Technology, 1955
Books
Selected Abstracts
Newly Elected Members
Awards and Honors
Food Industry Topics
Future Meetings

Dr. Clifcorn Elected 1955-56 President of Institute at Columbus Meeting

Dr. LaVerne E. Clifcorn, formerly Director of the Fundamental Research Division of Continental Can Company but as of June 1, 1955, Research Associate, Research Division of the American Can Company, has been elected the 1955-1956 President of the Institute of Food Technologists. He succeeds Dr. Philip K. Bates of the Research Division of the Carnation Company, Van Nuys, California. Dr. Clifcorn accepted the gavel symbolizing his new office on June 15, 1955, at the 1955 annual meeting in Columbus, Ohio.

Dr. Clifcorn was born in Rockford, Illinois, August 28, 1906. He was educated at the University of Wisconsin, receiving his A.B. degree in 1928, A.M. in 1930 and Ph.D. in 1934, majoring in inorganic chemistry and biochemistry. His studies with Professors Edwin Bret Hart, C. A. Elvehjem, and H. E. Steenbock at the University of Wisconsin directed his early attention to the field of foods and nutrition. His associations with them formed the pattern of most of his professional career concerned with the nutritional aspects of food.

While doing graduate work at the University of Wisconsin, Dr. Clifcorn was employed in the laboratories of the Wisconsin State Chemist where he gained valuable experience in the analyses of materials used as feeds. He was also one of the contributors to the development of iodized salt for the prevention of endemic goitre and together with E. B. Hart and W. B. Griem holds a patent on the stabilization of iodine in salt and other feed materials.

In 1936, Dr. Clifcorn joined the staff of the Continental Can Company, Inc. as a research chemist, was promoted to head of the Analytical Laboratory and later became Director of Product and Process Research. In 1950, he became Director of the Fundamental Research Division.

Since the inception of the Nutrition Foundation, Inc., in 1941, Dr. Clifcorn has been a member of the Industry Advisory Committee. He also was appointed a member of the Committee on Foods of the Advisory Board of the Quartermaster Research and Development of the National Research Council in 1949 and a member of the Subcommittee on Nutrition in 1951. In 1941 he was appointed a member of the Executive Committee of the National Canners Association—Can Manufacturers Institute Nutrition Program, directing the work which was initiated for the purpose of studying the nutritional aspects of canned foods.

Dr. Clifcorn has been extremely active in the affairs of the American Chemical Society, serving as Chairman of the Fifth National Chemical Exposition in 1948; Director of the Chicago Section, ACS; Secretary, Chairman-Elect, and Chairman of the Division of Agricultural and Food Chemistry; and is presently serving as a representative of ACS on the Advisory Panel of the Committee on Food Protection of the National Research Council.

Dr. Clifcorn is a charter member of the Institute of Food Technologists and has served on many committees concerned with the Institute's activities which have included the Program Committee, Committee on Exhibits, Committee on Education and Curriculum, Committee on Membership, and the Committee on the Training and Professional Status of the Food Technologist.

Dr. Clifcorn served as Chairman of the Panel on Food, Research and Development Board, Department of Defense, 1953. In addition he is serving on the Editorial Advisory Committee of the Journal of Agricultural and Food Chemistry and is a member of the Committee on Low Sodium Diets, Subcommittee on Radiation Sterilization, and the Industry Committee of the Industrial Liaison Panel, Food Protection Committee, National Research Council, in addition to Alpha Chi Sigma, Phi Lambda Upsilon, and Sigma Xi.

Dr. Clifcorn is the author of numerous publications in the field of food and nutrition and the holder of several patents concerned with the improvement of processing of canned foods. He has been associated with many canning developments including blanching of vegetables, flash sterilization of tomato juice and other fruit juices, corrosion and discoloration problems related to canned foods, aseptic canning, canning of whole and evaporated milk, effect of agitation on the processing of canned foods, development of steam-vac equipment for producing vacuum in canned foods, studies on nonenzymatic browning of canned foods as well as many others.

Dr. Clifcorn is an avid hunter and fisherman and maintains a profitable hobby of raising mink.

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FOR BAKED PRODUCTS AND FOR PREPARED MIXES

It is common knowledge that when "carry-through antioxidants" are used to stabilize shortenings, they are also selected for their ability to protect *baked products* against the development of rancidity. Sustane Six, containing only carry-through antioxidants as a synergistic mixture of BHA and BHT, offers maximum protection to baked goods.

Prepared mixes also need a stable carry-through antioxidant. While it is true that an antioxidant used in stabilizing a mix is not subjected to baking temperatures, to be most effective it must retain its full potency *after* the shortening is mixed with the product ingredients. A shortening stabilized with Sustane Six retains its *full* stability in a prepared mix.

For further details about Sustane Six write to:

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UNIVERSAL OIL PRODUCTS COMPANY
30 ALGONQUIN ROAD, DES PLAINES, ILL., U. S. A.

NEWS from ROCHE

Beta CAROTENE 'Roche'

(an exclusive Roche development)

ADVANTAGES for food processors

NATURAL COLORING

Beta carotene is the natural coloring matter of butter and other dairy products and is a constituent of cereal grains, alfalfa, carrots, and other vegetation. 'Roche' beta carotene imparts a *true* natural yellow color without any tinge of green. It does not change to a reddish color as do some vegetable pigments during storage.

ADDS NUTRITIONAL VALUE

Theoretically, one gram of pure beta carotene is equivalent to 1.67 million U.S.P. units of vitamin A. High retention of beta carotene-vitamin A activity is achieved in baked goods and other foods when margarine and shortening containing added beta carotene 'Roche' are used.

COLOR STABILITY

Extensive laboratory data show excellent color stability of margarine, butter, shortening, cheese, edible oils and yellow bakery products which were colored with beta carotene 'Roche'.

UNIFORMITY

The high degree of purity and color stability ensures uniform and constant intensity of color when using equal amounts per batch.

USAGE

In margarine and shortening. Canned measured amounts of beta carotene with vitamin A in vegetable oil for margarine batch requirements are available to meet specifications of the margarine manufacturer. The contents of the can dissolve readily in the warm margarine oils with uniform distribution throughout the batch.

A semi-solid stable suspension of beta carotene in vegetable oils containing 400,000 U.S.P. units of vitamin A activity per gram dissolves quickly in warm margarine oils or warm fluid shortening when added separately from the vitamin A concentrate. This addition contributes a uniform distribution of color and a substantial amount of vitamin A.

The amount of beta carotene customarily used to color one pound of margarine is generally in the range of 5000 to 6000 U.S.P. units of vitamin A activity. The amount required to color a pound of shortening represents 8000-9000 units.

In butter. Beta carotene may be used to improve the low color and vitamin A level of winter butter. A stable suspension of beta carotene in butter oil containing 500,000 U.S.P. units of vitamin A activity per gram is available for butter processing.

In cheese. Beta carotene has greater advantages than other colors permitted in cheese in that beta carotene is the natural coloring in dairy products and contributes vitamin A.

In bakery and confectionery products. Beta carotene is easily introduced into most bakery and some confectionery products by incorporating the required amount of beta carotene suspension with the margarine, butter or shortening.

Other foods. Detailed information about the application of 'Roche' beta carotene on request.

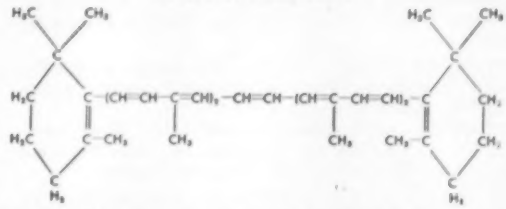
for processors of { Margarine • shortening / butter • cheese / yellow baked goods / edible oils

now in commercial production

TECHNICAL information

Empirical Formula: $C_{40}H_{56}$

Structural Formula:



Crystalline beta carotene 'Roche' is in the all trans form

Color-Vitamin A Relationships

Margarine. The amount of beta carotene required to produce an acceptable color in margarine ranges from 0.0030-36 grams (5000-6000 U.S.P. units of vitamin A activity) per pound.

Shortening. The average amount required to color shortening is 0.0051 grams (8500 U.S.P. units of vitamin A activity) per pound.

Butter. Acceptable butter color, especially in winter butter can usually be obtained by adding 0.0006 to 0.0030 grams beta carotene (1000-5000 U.S.P. units vitamin A activity) per pound.

Molecular Weight: 536.85

Melting Point: 183.0

Appearance: Red-violet platelets

Solubility in Edible Oils:

At room temperature	about 0.08%
At 60°C	about 0.2 %
At 100°C	about 0.8 %

Biological Properties:

0.6 microgram beta carotene: 1.0 U.S.P. units of vitamin A

1.0 gram beta carotene: 1,666,666 + U.S.P. units of vitamin A

PACKAGING

33-pound steel pails, double Synthetasine lined, with removable-replaceable-leverlok cover.

3-pound tripletite tamperpruf metal cans.

Batch size cans of Vitamin A and Beta Carotene 'Roche' blended in vegetable oil to your specifications.

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400,000 U.S.P. units per gram
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Regional Section News

CHICAGO SECTION

Eighty-seven members and guests convened at 6:00 P.M. in the Palmer House for the social period and dinner. An excellent menu which included a grapefruit cocktail, unusually fine veal cutlets and ice cream filled chocolate eclairs provided the right impetus for a successful meeting of Food Technologists.

Program Chairman, R. H. Maher, introduced Dr. C. D. Carpenter, President of the Institute of American Poultry Industries, who spoke on the "Influence of Research on the Poultry Industries."

Fifty years ago poultry subsisted by foraging in the fields, supplemented by occasional feed from the farmer. The quality of meat left much to be desired. Egg laying was primarily limited to the spring mating season. The reproductive cycle was encouraged by inducing a hen to set on eggs of doubtful fertility.

Poultry research, as we know it today, had its beginnings with the discovery at Cornell University (1906-07), that the feeding of animal proteins to chickens would extend the egg-laying period. The yield of healthy live chicks was greatly increased when kerosene-heated incubators were introduced in the early 1920's. This equipment has given way to the thermostatically controlled, walk-in type incubator with automatic egg turning machinery.

Research in formulated feeds has resulted in a current yearly production of 35 million tons of feeds. Poultry consumes 61½% of this.

The discovery that turkeys kept apart from chickens were less likely to contract the often fatal blackhead disease, has resulted in our present day three-quarter billion dollar turkey industry. Research on commercial broilers and caged layers is largely responsible for the high quality and quantity of poultry meat.

Poultry research has had a remarkable effect on allied industries, such as those producing clear plastic egg cartons, prepared cake mixes, bottle crowns (egg albumin adhesives) and fine finishes for leather.

The Institute of American Poultry Industries encourages the Public and Industry to take advantage of the knowledge it has gained through research in breeding, feeding, sanitation, processing, advertising, and merchandising. The Fact Finding Conference held yearly in Kansas City brings Industry and Research personnel together to discuss mutual problems. A Junior Conference has been included in the past few years.

OHIO VALLEY SECTION

The spring meeting was held at the Ohio State University in Columbus on Saturday, April 16. Two national officers of the Institute attended the meeting. Colonel Charles S. Lawrence, Executive Secretary, came from Chicago to help with plans for the National Convention to be held in Columbus, June 12 to 16. The other guest was Dr. L. E. Clifcorn, also of Chicago, who is Associate Director of Research for Continental Can Company and newly elected President of the Institute of Food Technologists. Dr. H. D. Brown had asked Dr. Clifcorn to speak to various groups at the University who are interested in food technology.

Luncheon and Program. After a morning session attended by committee chairmen for continued work on 1955 Convention plans, the Ohio Valley Section meeting was opened with a luncheon in Pomerene Hall. More than fifty members and guests from points in Ohio, Indiana, and Kentucky were present for the luncheon.

Dr. George F. Garnatz, Chairman of the Section, introduced the guest speaker, Dr. Clifcorn, whose subject was "Ionizing Radiation Sterilization of Foods." Dr. Clifcorn in an interesting and able manner described the means of radiation which have been applied to various foods, the effects obtained in retarding spoilage, and some of the barriers to the immediate application of this method in food preservation.

Afternoon Program. The afternoon program was held in Campbell Hall auditorium and had been arranged by R. C. Overbeck and R. F. Robinson of Battelle Memorial Institute and Dr. F. E. Deatherage of Ohio State University. The four speakers presented challenging information on the following diversified subjects:

"Instrumentation in the Food Industry," by Mr. Roy E. Post, Industrial Engineer, Columbus area, Foxboro Instrument Company.

"Manufacturing Problems in the Cheese Industry," by Mr. O. W. Woodyard, Food Technologist, Cudahy Packing Company, Washington C. H., Ohio.

"Instrumentation for Statistical Control in the Food Industry," by Mr. William Hecox, Assistant Chief, Electrical Engineering Division, Battelle Memorial Institute.

"The Whale and Where He Fits in the Food Industry," by Dr. Iver Igelsrud, Chief, Technical Information Division, Battelle Memorial Institute.

During the business session, the following officers were elected for 1955-56: Chairman, Dr. F. E. Deatherage; Vice Chairman and Chairman-Elect, Mr. Robert A. Wait; Secretary-Treasurer, Miss Beatrice Finkelstein; Councilor, Dr. H. D. Brown; Executive Committee, Mr. Fred Dellwo and Mr. Oliver J. Fiala, two-year term, and Dr. W. A. Gould, one-year term.

SOUTHERN CALIFORNIA SECTION

At the April meeting, Mr. William J. Scarlett of the Industrial Division of Minneapolis-Honeywell Co., Philadelphia, addressed the Section on "Instrumentation in the Food Industry." According to Mr. Scarlett, the ratios of money spent on instrumentation per unit total plant investment are 8 to 7 to 1 for the petroleum industry, the chemical industry, and the food industry, respectively.

He outlined 9 categories into which the food industry may conveniently be divided: meat, grain, dairy, confections, canning, freezing, sugar, tobacco (!), and beverages. He gave the manufacture of candy bars as an example of successful automation, and announced the development of a sugar super-saturation meter. Mr. Scarlett concluded with an enumeration of the advantages of instrumentation: it eliminates human error, increases speed, improves quality, avoids spoilage, reduces cost, and increases uniformity.

(Continued on page 8)

How to woo the diet shopper

She won't (or she can't) use sugar-sweetened products.

She knows SUCARYL; *she's used it in her home.*

She'll buy—actually shop for—your SUCARYL-*sweetened line.*

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SUCARYL is an entirely new substance, called Cyclamate. Its great advantage is a clean, sugar-like sweetness unmarred by the sharp, bitter aftertaste of other synthetic sweeteners. Also, it lends itself beautifully to your manufacturing processes.

Of course, you won't know this until you try it. And we would like to have you try SUCARYL—with our compliments—in your product. No obligation. Just tell us whether you prefer SUCARYL Sodium or SUCARYL Calcium, and write to: Chemical Sales Division, Abbott Laboratories, North Chicago, Illinois. Abbott

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The New Non-Caloric Sweetener

REGIONAL SECTION NEWS

(Continued from page 6)

SOUTHERN CALIFORNIA SECTION

Wednesday May 18, was the date and the weather was fine. The Rodger Young Auditorium provided the space and an excellent chicken dinner. Our speaker was Herbert Dickow, Vice-President of Heinz & Co., Inc., and his talk entitled "Product Evaluation from the Standpoint of Consumer Acceptance" was itself a product evaluated highly by the Food Technologists present.

In order to promote a successful marketing program, it is essential that management learns the important details regarding consumer acceptance. Not always the same factors are the most important ones, according to Mr. Dickow, and hence marketing research is indicated before advertising or even evaluation of men and machinery. The combination of competition, prosperity, and research has led to steady improvement, quality-wise, in every branch of the food industry.

The importance of high quality — flavor, aroma, appearance, shelf-life, freedom from defects—to the survival of a given product is incontrovertible; but other factors, sometimes of seeming insignificance, often prove decisive. For example, oleo sells better in yellow cartons than in blue, and glass containers are preferred for some products because of visibility, but disliked for others because of fear of breakage.

Sometimes the acceptance of a product depends upon educating the public to appreciate certain dietetic values. The sale of cottage cheese has increased 50% in California since 1947, attributable in part to a discreet campaign pointing up the advantages of a high protein, low fat, and low calorie diet.

NORTHEAST SECTION

The last meeting of the 1954-55 season of the Northeast Section was held at the University of Massachusetts at Amherst, Mass., on May 14, 1955.

Mr. Roy H. Walters, Vice-president of General Foods, spoke on "Food Research at General Foods Corporation." Mr. Walters was presented with a membership in Phi Tau Sigma by Dr. Gideon Livingston, national president, who is a faculty member of the Food Technology Department at the University of Massachusetts.

Prof. Ernest E. Lockhart receiving badge of office from Dr. Jean F. Caul. Dr. Gideon Livingston on right and Mr. Roy H. Walters, hidden by lectern.

After the treasurer's report by Dr. Arthur S. Levine, which indicated that the organization is still solvent, Dr. Jean F. Caul, of the Arthur D. Little Co., Inc., transferred the gavel of authority and other pertinent certificates of office to the new chairman of the Section, Dr. Ernest E. Lockhart, associate professor of food chemistry at the Massachusetts Institute of Technology.

NEW YORK SECTION

Vitamin Progress Reported. Significant to food processors and consumers is the progress being made in the production of synthetic beta carotene, a pro-vitamin A which can be used to impart a yellow color to products while increasing their nutritional value.

This progress was highlighted by J. C. Baurenfeind, Hoffmann-La Roche, Inc., Nutley, N. J., at the May 18 meeting of the New York Section of the Institute of Food Technologists. Dr. Baurenfeind presented the following interesting facts:

Just as 1950 was the important year in the beginning of large-volume industrial preparation of synthetic vitamin A, so 1955 marks the beginning of large-scale commercial production of synthetic crystalline β-carotene. β-carotene is manufactured by the Inhoffen-Isler process at Hoffmann-La Roche Inc. from citral through the C_{14}-aldehyde intermediate to a C_{19}-aldehyde, then on to a C_{40} diol which upon dehydration, hydrogenation and isomerization yields β-carotene, $C_{40}H_{56}$.

Pure β-carotene is a brownish-red, violet-tinted crystalline powder. It dissolves in oil and organic solvents to produce a yellow-orange color. Commercial preparations are (1) a 24% β-carotene suspension in vegetable oil in bulk packaging and (2) β-carotene-vitamin A blends in vegetable oil in sealed cans in custom amounts for batch processing.

β-carotene is the most important of the pro-vitamins A and is converted into vitamin A by the human and animal organism. One international unit of vitamin A activity is supplied by 0.6 micrograms of β-carotene or 0.3 micrograms of vitamin A (alcohol). Roche synthetic β-carotene corresponds both in chemical structure and biological activity to β-carotene from natural sources.

Vitamin A and β-carotene can both be added to food products to contribute improved nutritional value by standardizing vitamin A content. Carotene provides color in addition to vitamin A value. In the food industry, β-carotene is the ideal physiological coloring matter. Natural carotene concentrates are already available for this purpose. The large-scale synthesis of β-carotene now permits a wider application of the coloring agent.

Carotene is the natural coloring matter of butter, which gives it its characteristic yellow-orange color. Therefore, from a consideration of the natural properties of butter and from the regulatory point of view, the use of added carotene for the coloration of butter is indeed an excellent way of standardizing color in the future. In so doing, the vitamin A activity of winter butter is improved and a vitamin A standardized product can be manufactured. Legally, vitamin A, ex-

(Continued on page 10)

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REGIONAL SECTION NEWS

(Continued from page 8)

cept as carotene, cannot be directly added to butter at the present time.

β-carotene is commercially used in shortening to provide coloring and in margarine for coloring and vitamin A value. Practically all large margarine manufacturers are currently using, or plan to use, carotene in margarine. A carotene-colored shortening for home use is being extensively marketed. Excellent stability of added carotene in margarine and shortening has been observed. Furthermore, baked goods prepared with carotene-colored shortening, and margarine, demonstrate good retention of color through the baking process. Carotene will continue to be used to provide a pleasing yellow color in cakes, cookies, special breads and sweet goods in such carriers as margarine, shortening and possibly even frozen egg yolks. Carotene can be used to color all food products which contain or permit the addition of fat. Carotene is not water-soluble.

Egg yolks naturally contain β-carotene as well as other carotenoids. Dark-colored frozen yolks are difficult to obtain under current poultry management and feeding practices. One meritorious approach to be worked out in the future would be to add carotene to yolks prior to the freezing process.

Interest has been shown in coloring confections, fruit products, dried pastes, dessert powders, etc. In fact, β-carotene is worthy of consideration in any food product where a fat-soluble yellow-orange coloring agent is desired.

Sherwood Elected President. R. C. Sherwood, Sterwin Chemicals, Inc., has been elected president of the New York Section of the Institute of Food Technologists for the 1955-56 term.

J. C. Bauernfeind, Hoffmann-La Roche, Inc., is vice-president; A. Astrack, treasurer; and Ruth Bien, Good Housekeeping Bureau, secretary.

OREGON SECTION

The annual luncheon meeting was held in the Astor Hotel, Astoria, Oregon on May 6. The Ernest H. Wiegand Award Plaque was displayed and Richard D. Sleeper, winner of the 1955 award was introduced. Mr. Sleeper thanked the Oregon Section as co-sponsors of the award for its confidence in choosing him as the award winner.

The following officers were elected for the 1955-56 year: Chairman: Edward W. Harvey, Associate Food Technologist in charge of Seafoods Laboratory, Food Technology Dept., Oregon State College, Astoria, Oregon; Vice Chairman: Alton C. McCully, Research Director, Eugene Fruit Growers Association, Eugene, Oregon; Secretary-Treasurer: Curtis J. Wilder, Assistant Food Technologist, Food Technology Dept., Oregon State College, Corvallis, Oregon; Councillor: Charles L. Beardsley, Food Technologist, Apple Growers Association, Hood River, Oregon; Executive Committee: George P. Henken, Assistant Maintenance Superintendent, Blue Lake Packers, Salem, Oregon, and Arthur W. Anderson, Assistant Professor of Bacteriology, Bacteriology Dept., Oregon State College, Corvallis, Oregon.

In the afternoon the group enjoyed a very interesting tour through the Columbia River Packers Association plant in Astoria. Salmon and tuna canning operations were studied. These operations included everything from receiving the fish through grading, raw product preparation, canning, retorting, labelling and oil recovery methods. The group was impressed by the cleanliness of the plant and operations. After the C.R.P.A. tour everyone stopped in the Seafoods Laboratory and saw the research facilities used in aiding the fishery industry in its problems of preserving the seafoods of the Pacific Northwest. The meeting came to a close at 4:00 p.m.

NORTHERN CALIFORNIA SECTION

Gleanings from the Section's publication: IFT *Hornblower*, March-April issue.

Mr. John W. Bristow, Executive Vice President and Secretary-Treasurer of the California Processors and Growers, addressed the April 14th meeting held in the Merchandise Mart, San Francisco. His topic: "Why People Work." . . . Joseph O. Mueller, in charge of quality control for Schenley Distillers spoke to the San Joaquin Sub-section on March 15. He discussed the importance of preference and difference tasting in food manufacture. Dr. Emil Mrak was slated to speak to the April 19th meeting. . . . Mr. B. G. Grossi, Associate Director of Research of the Gerber Products Company, addressed the Delta Sub-section on March 3 at the El Tehran Restaurant, Stockton. He spoke on some of the problems in connection with the use of insecticides and pesticides. . . . The Northern Section's Annual Picnic was held on May 21 at the Pink Horse Ranch, The Adobe Creek Lodge near Los Altos.

PERSONNEL

Dr. H. A. Campbell, long active in IFT affairs and in the scientific societies generally, has been named manager of technical research in New Products Department of General Foods. Dr. Campbell, a graduate of the University of Illinois, holds his doctorate from the University of Wisconsin. He joined General Foods in 1939 as a research chemist and moved up to his present position through various scientific administrative posts, the most recent being manager of research staff services.

At the annual meeting of the American Institute of Chemists held in Chicago in May, Dr. Lloyd A. Hall was elected to the Board of Directors of the AIC and to a three-year term as councilor-at-large.

Honoring Professor W. V. Cruess, Babcock-Hart Award Winner for 1955 and first recipient of the Nicholas Appert Award, a banquet was held in San Francisco, June 2nd, to commemorate the achievements of this distinguished teacher, investigator, and author. The banquet, sponsored jointly by the Northern California Section of IFT and Dr. Cruess' colleagues at the University of California, was the occasion for the unveiling of a portrait of Dr. Cruess.

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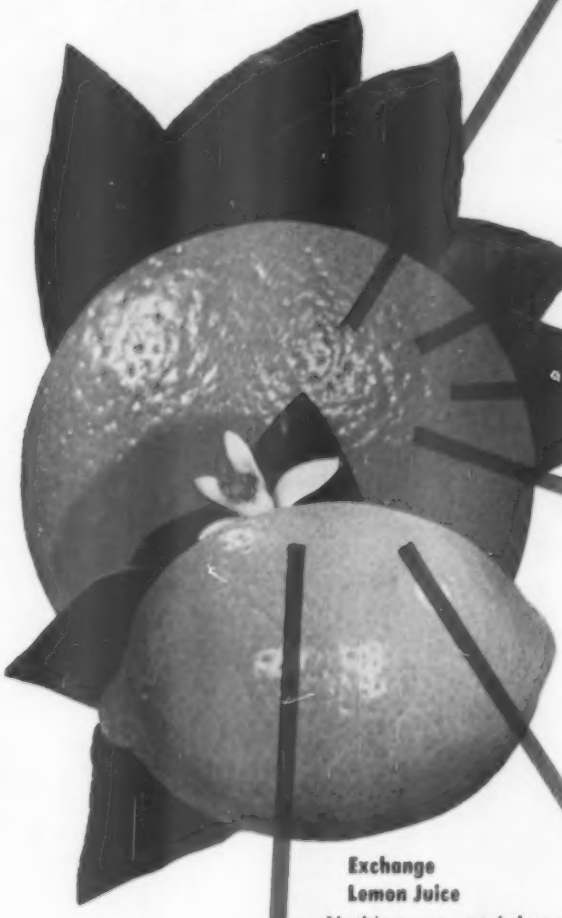

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Masters and Doctors in Food Technology — 1955

Another year and another class of academically commissioned food technologists! The roster for 1955 shows the same diversity of thesis problems as in former years, a spread of research interest that few if any would disapprove. Work has been done on the conventional problems of food research and on problems that require "bold approaches."

An aspect of the 1955 and previous rosters of graduates in food technology that is worthy of special comment is the number of young scientists on the lists who come to us from nations overseas. This fact is not evident from the surnames—since American names are global in origin—but it is readily verifiable through the records of college registrars. In many areas of the world where the modernization of food manufacture has only recently become an object of national concern and interest, these young specialists have an enviable career ahead of them. They will, in truth, be the "architects of a new tomorrow" in the food industry and economy of their native lands.

The lists that follow are alphabetized according to institutions and, within institutions, according to the names of graduates. The courtesy of those who have supplied these lists from the records of their various institutions is gratefully acknowledged.

UNIVERSITY OF CALIFORNIA AT DAVIS

Name	*Degree*	*Thesis or Dissertation*
Conroy, Albert	M.S.	The Freeze-Drying and Subsequent Storage of Animal Products
Dame, Charles	M.S.	Role of Organic Acids and Sugars on Quality of Canned Bartlett Pears
David, John	M.S.	A Chromatographic Study of Organic Acids of Canned Peaches
Lew, Yolk T.	M.S.	Inhibition of Hematin-Catalyzed Unsaturated Fat Oxidation
Schade, John	M.S.	The Induction of Trehalase in *Candida tropicalis*
Siddiqi, Abul M.	M.S.	Catalysis of Linoleate Oxidation by Pea Lipoxidase

CORNELL UNIVERSITY AT ITHACA, NEW YORK

Darragh, Richard Thomas	M.S.	Effects of Benzoic and Salicylic Acids on Lactic Acid Apodehydrogenase as Measured Spectrophotometrically
Ferrari, Richard Allen	M.S.	Colorimetric Determination and Partitioning of Mixtures of Fatty Acids
Frank, Stefan Sebastian	M.S.	Phosphates and the Water-Binding Capacity of Meats
Zampelas, Demetrios Antony	M.S.	Separation of Some Organic Acids from Wine by Partition Chromatography

UNIVERSITY OF GEORGIA AT ATHENS

Huff, Robert F.	M.S.	Spoilage of Inoculated Cans of Field Peas as Related to Heating Times, Heating Rates, and Spore Destruction Rates
Lee, Ki Yull Miss	M.S.	The Influence of Cocoa and Cocoa Components on the Utilization of Dietary Fat, Protein, and Calcium and Growth of the Male Mouse
Malcolm, Henry Ray	M.S.	Development of Objective Methods of Determining the Nature of Field Peas
Perdue, Richard R.	M.S.	Polarographic Determination of the Anthocyanin Content of Foods
Ready, Charles A.	M.S.	Effect of Nutrients and Poising Compounds on the Fermentation of Pickles
Whitehead, Elizabeth L. (Mrs.)	M.S.	Milk Drinking Habits of the Students of the University of Georgia

ILLINOIS INSTITUTE OF TECHNOLOGY AT CHICAGO

Albrecht, James Joseph	M.S.	Studies in the Cold Sterilization of Milk Using Mercury Resonance Radiation

UNIVERSITY OF ILLINOIS AT URBANA

Aaland, A. E.	Ph.D.	A Study of the Stability of Thermal Polymers of Ethyl Linoleate Toward Oxidation
Bhalerao, V. R.	Ph.D.	A Method for the Detection of Foreign Fats in Dairy Products
Brachfeld, B. A.	Ph.D.	Factors Affecting the Viability of Spores of *Bacillus stearothermophilus*
El Bisi, H. M.	Ph.D.	The Effect of Certain Sporulation Conditions on the Thermal Death Rate of *Bacillus coagulans* var. *Thermoacidurans*
Hayes, R. E.	Ph.D.	Studies on the Sulfiting of Sweet Corn
Hoover, J. K.	M.S.	
Kalbag, S. S.	Ph.D.	Sugar Phosphate Derivatives of Higher Fatty Acids
Lombard, S. H.	Ph.D.	Investigation of the Stale Flavor which Develops in Dried and Sterile Whole Milk
Pippitt, R. G.	M.S.	Treatment and Utilization of Extracted Soybean Flakes for Human Consumption
Sakuragi, T.	Ph.D.	The Synthesis and Biological Utilization of Various Esters of Linoleic Acid
Saleh, M. A.	Ph.D.	Studies of the Growth and Toxin Production of *Clostridium botulinum* in a Precooked Frozen Food-Inhibition by Lactic Acid Bacteria
Spotholz, C. H.	Ph.D.	A Study of Certain Environmental Factors
Witting, L. A.	Ph.D.	Nutritive Value of Polymerized Fats
Yao, K. T.	Ph.D.	Factors Affecting the Vacuum Dehydration of Chicken Meat

UNIVERSITY OF MARYLAND AT COLLEGE PARK

Bibi, M. Zuhair	B.S.	Suitability of Six Freestone Peach Varieties for Canning and Freezing and the Relation of Certain Factors to Quality of the Processed Fruits
Elehwany, Nazmy E.	Ph.D.	Chemical and Physical Changes as Related to Maturity of Raw and Processed Sweet Peas
Twigg, Bernard A.	M.S.	Cultural Studies with Matai, *Eleocharis dulcis* (Burm.f.)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY AT CAMBRIDGE

Farkas, Daniel F.	M.S.	High Temperature Enzyme Inactivation
Lirot, Stephen J.	M.S.	Factors Affecting Quality of Precooked Frozen Fish Sticks
Malaspinas, Alexandros S.	Ph.D.	Nutritional Evaluation of Heat-Treated Fat
Remmers, Edward G. (Doctor of Science)	D.S.	Experimental Attainment of Optimum Conditions
Starr, Lawrence D.	M.S.	Effect of Chemicals on Storage Life of Fresh Pork Sausage

(Continued on page 14)

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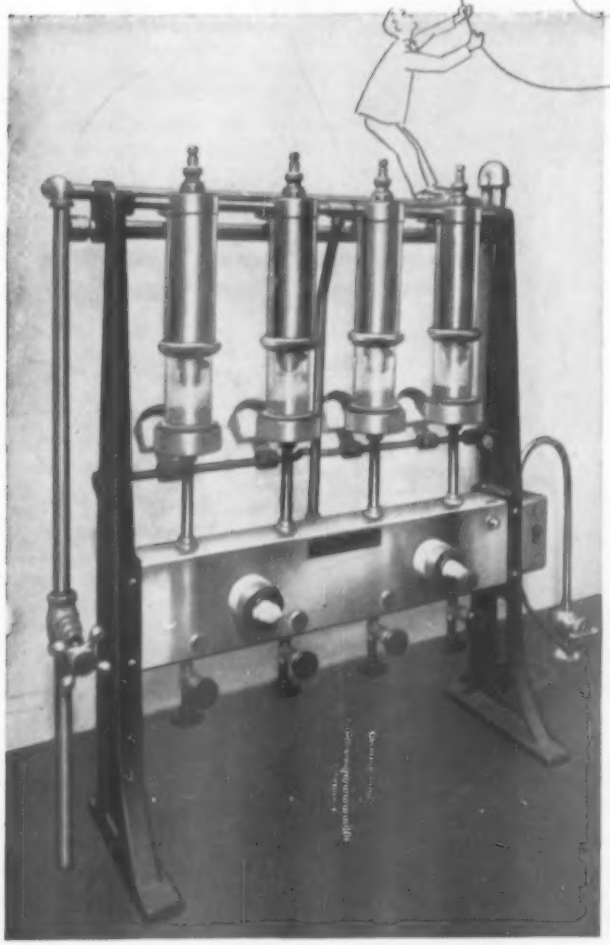

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Masters and Doctors in Food Technology—1955

(Continued from page 12)

UNIVERSITY OF MASSACHUSETTS AT AMHERST

Name	*Degree*	*Thesis or Dissertation*
Baldauf, Milton Paul	Ph.D.	Nonenzymic Browning of Pureed Carrots
Decareau, Robert Vincent	Ph.D.	Color in Relation to Processing Strawberry Products
El-Mohandes, Abdel Tawab	Ph.D.	Nutrition Studies on Fenugreek
Duval, Paul D.	M.S.	Effect of Heavy Metals on Honey Color and Use of Sequesterene in Improving Color
Gagnon, Marcel	M.S.	A Study of Canadian Fish Species in Fish Stick Preparation
Jackson, Richard Field	M.S.	Keeping Quality of Prepackaged Fresh Poultry
Kaplow, Milton	M.S.	Thermal Destruction of Peroxidase in Vegetables
Lampi, Rauno Andrew	M.S.	Use of Non-Caloric Sweetening Agents in Canned Fruits
Markakis, Pericles	Ph.D.	Studies on Strawberry Pigments
Megally, Mourad Amin	M.S.	Nutritive Study of a Corn Meal Ration Supplemented by Fenugreek
Miller, Tilford Day	Ph.D.	Thermal Activation of Bacterial Spores
Misiaszek, Eugene John	M.S.	A Study of Reaction Times of Papain in Egg Yolk
Naik Kurade, Anand Gopinath	M.S.	Preparation and Properties of Coconut Milk
Ouellet, Laurent	Ph.D.	Nutritional and Utilization Studies of the Deep Sea Quahog
Powrie, William Duncan	Ph.D.	Kinetics of Gelation of Egg Yolk on Freezing and Thawing
Rotman, Alan Lawrence	M.S.	Stability of Color in Carbonated Beverages
Servadio, Gildo Joseph	M.S.	Use of Free and Bound Ammonia as an Indicator of Quality in Fresh Fish Flesh
Thompson, Peter C. O.	M.S.	Isolation of Quinic Acid from Cranberries
Webster, Peter Cushman	M.S.	Thermal Destruction Rates of Food Poisoning Bacteria

MICHIGAN STATE COLLEGE AT EAST LANSING

Coughlin, Frank M.	M.S.	Sorbic Acid as a Selective Agent in Cucumber Fermentations
Ferguson, William E.	M.S.	Inhibitory Effect of Sorbic Acid on Yeasts Associated with Cucumber Fermentations
Kahl, William	M.S.	Distillation of Peppermint Oil
Levin, Jordan H.	M.S.	An Engineering Analysis of the Farm Handling and Packaging of Cultivated Blueberries
Meloche, H. Paul	Ph.D.	Nutrition of *Acetobacter aceti*
Newcomer, J. Leon	M.S.	Effects of Ultrasonics on Milk
Perry, John	Ph.D.	Basic Relationships in the Storage of White Pea Beans
Ragheb, Hussein S.	Ph.D.	The Influence of Corn Steep Liquor, Sugar and Amino Acids on Cucumber Fermentation
Robach, Donald L.	M.S.	Comparison of the Morphological, Cultural and Physiological Chracteristics of Nitrate Reducing Strains of *Lactobacillus plantarum* with Non-Reducing Strains
Townsend, William E.	M.S.	Color Stabilization of Prepackaged Frozen Meat by the Use of Carbon Monoxide
White, Lawrence S.	Ph.D.	The Incidence and Pectolytic Activity of Molds Isolated From Tomato Fruits in Indiana and Ohio

UNIVERSITY OF MISSOURI AT COLUMBIA

Hedrick, Harold B.	M.S.	Effect of Plane of Winter Nutrition on Quality of Beef
Henrickson, Robert L.	Ph.D.	Preparation of Dehydrated Pork of Lowered Glucose Content
Wilson, Neil B.	M.S.	Sensory Discrimination as It Relates to Various Grades and Weights of Beef

NORTH CAROLINA STATE COLLEGE AT RALEIGH

Heimbuch, Alvin H.	Ph.D.	Characteristics of a Growth Factor in Corn Steep for *Lactobacillus casei*
Lazar, James T. Jr.	Ph.D.	A Method for Measuring the Efficiency of Labor Utilization in Market Milk Plants
Nelson, John Penry	M.S.	Labor Utilization in Milk Receiving Operations
Sandline, William E.	M.S.	Identification of a Peptide from Pancreas Tissue Stimulatory for Bacterial Growth
Slagle, Albert G.	M.S.	A Study of Labor Utilization in the Receiving, Processing, and Packaging Operations in Six North Carolina Fluid Milk Plants

OREGON STATE COLLEGE AT CORVALLIS

Aref, Moustafa	Ph.D.	The Nature of the Flavors of Filbert Nuts *(Corylus avellana)*
Athanassiadis, Costas	M.S.	Controlling Secondary Fermentations with New Preservatives
Hanneson, Gudlanger	M.S.	Factors Related to Growth Stimulation of Inhibition of Lactic Streptococci
Kalle, Gurudutt Pandurang	M.S.	The Effect of Reducing Microorganisms on the Rate of Color Development in Cured Meats
Macgregor, Dugal R.	Ph.D.	The Bactericidal Mechanism of Quaternary Ammonium Compounds
Narula, Prem N.	Ph.D.	Nitrogen Distribution in Goats' Milk
Rasheed, Abmed Adel	Ph.D.	Sex Hormone Influence on Rate and Efficiency of Gains, Endocrines, and Carcass Characteristics of Rabbits
Siegele, John L.	Ph.D.	Pigments in Green Beans and Their Qualitative and Quantitative Changes During Processing and Storage
Smith, Vincent	M.S.	Prevention of Bacteriophage Lysis of Pectic Acid Bacteria in Industrial Fermentation
Strauss, Marianne	M.S.	The Effect of Ingredient Variation on Chemically-Leavened Batter and Dough Products
Tinsley, Ian J.	M.S.	Methods of Presenting Raspberry and Strawberry Samples to the Hunter Color and Color Difference Meter
Valassi, Kyriake	Ph.D.	The Effect of Mixing Speeds on the Physical Properties of Cake Batters With and Without Fat Emulsifiers
Rosenfield, Daniel	M.S.	A Study of the Effect of Sodium Chloride on the Electrical Resistance and Capacitance of Lean Ground Pork

STATE COLLEGE OF WASHINGTON AT PULLMAN

Chakravarti, D.	Ph.D.	The Protein Stability and the Wettability of Milk Powder as Affected by Changes in Milk Composition

(Continued on page 16)

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Masters and Doctors in Food Technology—1955

(Continued from page 14)

RUTGERS UNIVERSITY AT NEW BRUNSWICK, NEW JERSEY

Name	*Degree*	*Thesis or Dissertation*
Donald, Elizabeth Ann	M.S.	Biomicroscopic Observation as a Method of Studying Nutritional Status
Kruiswyk, R.	M.S.	A Study of Methods for Cleaning and Pasteurizing Shell Eggs
Litman, I. I.	Ph.D.	A Study of Fat-Protein Complex in Powdered Milk
Nagnoush, M. R.	Ph.D.	The Oxidation-Reduction Potential as it Applies to Mold Growth

THE UNIVERSITY OF WISCONSIN AT MADISON

Gold, Harvey	M.S.	Relationship of Mechanical Harvesting of Green Snap Beans to Their Quality
Kuesel, Donald	Ph.D.	A Study of Methods of Determining Quality of Fresh and Processed Peas
Maze, Harold	M.S.	Sieve Size Distribution in Commercially Canned Peas

Books

METHODS OF BIOCHEMICAL ANALYSIS, Vol. II, edited by David Glick, Interscience Publishers, New York, N. Y. 470 pp., 1955.

The second of a series intended to cover annually the significant developments in biochemical analysis. Typical of review style book, chapters are contributed by different authorities, each covering a field of specialization. The thirteen chapters include:

1. Analysis of steroids by infrared spectroscopy—Harris Rosenkrantz (Worcester Foundation for Experimental Biology)—52 pp.
   Review of infrared principles, equipment and sample preparation. Curves are shown and correlated with steroid structure. Various portions of infrared curve are charted as correlated to steroids and steroid configurations.
2. Chemical determination of adrenaline and noradrenaline in body fluids and tissues — Harold Persky (Michael Reese Hospital, Chicago)—23 pp.
   Adrenaline reactions are discussed. Colorimetric and fluorometric methods of determination are described and compared.
3. Lipide analysis—Warren Sperry (N. Y. State Psychiatric Institute, and College of Physicians and Surgeons)—27 pp.
   Analytical methods for lipids in body tissues and blood. Analytical techniques are detailed. A new method for gravimetric determination of total blood serum lipids is proposed.
4. Measurement of lipoxidase activity—Ralph T. Hohman (Hormel Institute)—7 pp.
   Measurement of lipoxidase activity is discussed. Suggested techniques include O_2 uptake, peroxide measurement and spectrophotometric method on linoleate substrate.
5. Assay of compounds with folic acid acitvity—Thomas H. Jukes (Lederle Laboratories, American Cyanamid)—32 pp.
   Function of folic acid in biological functions is discussed. Microbiological and chemical assay methods are given as is a technique for citrovorum factor.
6. Determination of vitamin E—Robert W. Lehman (Distillation Products Industries)—36 pp.
   Many techniques for analyzing for group known as vitamin E are given in great detail. Methods include rat feeding, dipyridyl, Emmerie-Engel and many others. A thorough coverage.
7. Methods for determination of coenzyme A—G. David Novelli (Western Reserve Univ., Schl. Medicine)—25 pp.
   Detailed suggestions on many methods for analyzing for coenzyme A. Known reactions catalyzed by coenzyme A are tabulated.
8. Assay of proteolytic enzymes—Neil C. Davis and Emil L. Smith (University of Utah)—39 pp.
   Handy review of manifestations of proteolysis and methods of measuring it including formol titrations, ninhydrin and ammonia. Gasometric methods are given as well as spectrophotometric and colorimetric. Other miscellaneous methods are discussed including milk clotting, viscometry, dilatometry and others.
9. Determination of glutathione—J. W. Patterson and A. Lazarow (Western Reserve University and University of Minnesota)—17 pp.
   Techniques in analyzing for glutathione are discussed. Known techniques are reviewed and iodometric, glyoxalase and alloxan are given in detail.
10. Determination of serum glycoproteins—R. J. Winzler (University of Illinois)—25 pp.
    Nomenclature, pathology, physiology and analysis for serum glycoprotein are given. Methods discussed include protein-bound hexose, hexosamine and others.
11. New color reactions for determination of sugars in polysaccharides (Columbia University)—43 pp.
    Discussion of analysis for sugars, especially when they occur in small amounts in biological materials, is presented.
12. Recent developments in techniques for terminal and sequence studies in peptides and proteins—H. Fraenkel-Conrat, J. Ieuan Harris and P. L. Levy (University of California)—60 pp.
    Each author handles one section of this paper. Included are amino end group analysis, stepwise degradation and terminal group analysis. Finally, all collaborate to pull the subject together.
13. Spectrophotometric assay of cytochrome C oxidase—Lucile Smith (University of Pennsylvania)—6 pp.
    Assay discussed including sample preparation, interfering substances, reaction kinetics and result calculation.

Series serves to keep one posted in fields which are active and changing; hence this text will be requisite to anyone working in these fields.

ROY E. MORSE
Chicago, Illinois

(Continued on page 18)

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NOTE: For convenience in mailing, cut off Coupon and paste on 2c postcard. **F T**

BOOKS

(Continued from page 16)

AGRICULTURAL PROCESS ENGINEERING, by S. M. Henderson and R. L. Perry, John Wiley & Sons Inc., New York; Chapman & Hall, Ltd., London, Publishers, 402 pp., 1955.

This textbook is the third in the Ferguson Foundation Agricultural Engineering Series with an engineering approach to processing agricultural products. Since it is an inclusive text, primarily for the professional Agricultural Engineering Curriculum, it contains basic and necessary information on fluid mechanics, fluid flow measurement and heat transfer at the engineering level.

The subject of Agricultural Processing being very broad by nature, the authors have placed more emphasis on those processes closer to the agricultural field rather than the industrial field. This follows the trend of more processing and conditioning on the farm.

At the beginning of each chapter, the nomenclature used in the chapter is clearly defined. Every chapter is well illustrated with charts and appropriate photographs and although the formulae and equations provide solutions to some of the processes, the editorial material clearly discusses many of the details of processing.

Although not complete in treatment of all commercial processing equipment, the authors go into detail on much of the processing equipment found on farms, in elevators and custom feed mixers as well as food processing plants. The authors have written a compact, consistent textbook which will prepare the reader to handle many of the engineering aspects of most processing operations.

GERALD A. KARSTENS
Chicago, Illinois

ASPECTS OF DEEP SEA BIOLOGY, by N. B. Marshall, M.A. Illustrated by Olga Marshall. Philosophical Library, Inc., 15 East 40th St., New York, 380 pp., 1954.

In these times when population pressures tend to force man to turn more and more to the sea for his food, there would appear to be a greater need for a fuller understanding of the relation between the very varied forms of marine life and their environment. In his book Mr. Marshall describes the growth of the two closely related disciplines, deep sea biology and oceanography, from the time of the historic voyage of H. M. S. Challenger in 1872 until the present. The book is largely concerned with the marine life found in the great masses of ocean waters beyond the continental shelves. An account is given of the methods by which the deeper waters of the oceans are explored, including brief reference to echo sounding, types of nets used, and underwater photography and television. The importance of "deep sea food chains" is emphasized, and the writer advances the interesting conception of a "food pyramid" of which the minute plant forms, or phytoplankton, form a base and are followed by decreasing quantities of zooplankton and neckton (large fishes, whales, etc.). In reading this chapter one is impressed by the relatively minute amount of the total marine life which is used directly by man. In other chapters many interesting topics relating to marine animals are discussed including distribution and color at different depths, means of counteracting gravity, eyes and sense organs, bioluminescence, life histories of certain species and distribution in the oceans. The book is well written and is informative but not too technical. The author's wife has contributed many fine illustrations in black and white and several colored plates.

H. L. A. TARR
Vancouver, B. C.

Selected Abstracts*

ANALYTICAL METHODS

Partition chromatographic separation of aromatic acids.

BHARGAVA, P. M., AND HEIDELBERGER, C. *J. Am. Chem. Soc., 77,* 166-8 (1955).

The authors found a mixt. of 90% aq. MeOH and 0.5 *N* H_2SO_4 (9:1) as the stationary phase on a silicic acid column, and ligroin (Skellysolve B) as the mobile phase (both solvents equilibrated with each other), to be satisfactory for the sepn. of several aromatic acids.

Determination of fat in farinaceous products, especially those containing milk, by a modification of the Roese-Gottlieb method.

LEHNER, R., AND ESTOPPEY, A. *Mitt. Gebiete Lebensm. u. Hyg., 45,* 183-5 (1954); *Food Sci. Abstr., 27,* No. 123 (1955).

Starch is first degraded by diastase, and the fat is extd. from the ammoniacal substrate with EtOH, ether, and petr. ether.

Measurement of oxidation in dried milk products with thiobarbituric acid.

SIDWELL, C. G., SALWIN, H., AND MITCHELL, J. H. *J. Am. Oil Chemists' Soc., 32,* 13-16 (1955).

Steam-distn. of dry whole milk was found to be an effective means of scpg. the products of fat oxidation preparatory to reacting them with 2-thiobarbituric acid. Method is rapid, reproducible and the test solns. are free of turbidity. When applied to samples from storage, the results had validity in terms of flavor.

Comparison of methods for determining fatty acid oxidation produced by ultraviolet irradiation.

KENASTON, C. B., WILBUR, K. M., OTTOLENGHI, A., AND BERNHEIM, F. *J. Am. Oil Chemists' Soc., 32,* 33-5 (1955).

The thiobarbituric acid (TBA) reaction for fatty acid oxidation has been compared with Lundberg and Chipault's method for peroxides, the Kreis test for aldehydes, and with the degree of conjugation, using fatty acid esters exposed to u.v. light for various periods. The TBA test paralleled the other methods for Me linolenate and Me linoleate but was essentially neg. for Me oleate oxidation. This appears to be a reliable method of estg. the oxidation products of linolenic and linoleic acids in tissues and other biol. material.

A new reagent for the histochemical and chemical detection of calcium.

MCGEE-RUSSELL, S. M. *Nature, 175,* 301-2 (1955).

The dyestuff 'kernechtrot' or nuclear fast red has been found to be a sensitive reagent for the detection of Ca.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Stabilizing apple wine with glucose oxidase.

YANG, H. Y. *Food Research, 20,* 42-6 (1955).

An enzyme prepn. of glucose oxidase and catalase has been used to stabilize apple wine by the removal of O_2 and possibly by reducing the growth of HOAc bacteria.

The inhibition of trypsin. II. The effect of synthetic anionic detergents.

VISWANATHA, T., PALLANSCH, M. J., AND LIENER, I. E. *J. Biol. Chem., 212,* 301-9 (1955).

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Dr. H. A. Campbell and the General Foods Corporation of White Plains, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 20)

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SELECTED ABSTRACTS

(Continued from page 18)

Trypsin was inactivated by alkyl sulfates in the following order of increasing effectiveness: potassium octyl sulfate, sodium decyl sulfate, and sodium dodecyl sulfate. The theoretical implications of these observations were discussed in relation to what is known of protein-detergent interactions.

The diazomethol ysis of glycerolphosphatides. A novel method of determining the configuration of phosphatidyl serines and cephalins.

BAER, E., AND MAURUKAS, J. *J. Biol. Chem., 212,* 39-48 (1955).

A chem. procedure is reported by means of which phosphatidyl serines and cephalins can be cleaved at the ester bond linking the phosphatidic acid and nitrogenous moieties. The cleavage, which is accomplished with diazomethane, proceeds at room temp. and yields optically pure phosphatidic acid dimethyl esters.

Hydrolyzed fish protein from the flesh of waste fish.

MOHANTY, G. B., AND ROY, A. B. *Science, 121,* 41-2 (1955).

Waste fish was minced, boiled with dil. HOAc and extd. with petr. ether to remove the fat. The fat-free protein was made assimilable by alkali hydrolysis followed by a neutralization with HOAc. The neutralized liquid was spray-dried to yield a flour-like powder which was cream colored and retained its natural flavor. The yield was nearly 10% of the raw material. The product contained 85% protein and is claimed to be less expensive than similar products manufd. by other means. It is sol. in H_2O, has good keeping qualities and has better whipping power than egg albumen. It also contains all the amino acids essential to nutrition.

Mono-α-aminoacyl and mono-α-dipeptide triglycerides.

HUBER, W. F. *J. Am. Chem. Soc., 77,* 112-16 (1955).

2-α-Aminoacyl-1,3-dilaurins, -dipalmitins, and -distearins have been prepd. representing a combination of the acidic constituents of protein and fat in one mol. They were obtained as the acetate salts by hydrogenation of the corresponding 2-α-azidoacyl glycerides in glacial AcOH.

A new amino-acid from apples.

URBACH, G. *Nature, 175,* 170-1 (1955).

One of two previously unidentified amino-acids found in apples is indicated to be 4-hydroxy-methylproline.

Flame photometry. The quenching effect of chlorhydrocarbons on sodium and potassium estimations.

MILTON, R. F., AND DUFFIELD, W. D. *Chemistry & Industry, 280* (1955).

Chlorhydrocarbons used to prevent growth of mouldant bacterial degradation in biochem. solns. have quenching effect on flame photometry resulting in reduction of observed value. Elimination of this effect achieved by boiling soln. before detns. are made.

MICROBIOLOGY

Mycobacteria in fish liver oils.

PRICKETT, P. S., AND WIEHLE, W. E. *Appl. Microbiol., 3,* 26-9 (1955).

Acid-fast bacilli demonstrated microscopically in fish liver oils were found to be nonviable. Refined oils are not only sterile but are germicidal, probably due to their content of unsatd. alpha glyceryl ethers.

Resistance of Clostridium parabotulinum to sorbic acid.

YORK, G. K., AND VAUGH, R. H. *Food Research, 20,* 60-5 (1955).

Different strains of *C. parabotulinum* grew well and sporulated in media contg. up to 3.0% sorbic acid. Sorbic acid is, therefore, not a good fungistatic agent for these organisms.

Factors limiting total growth in bacterial cultures.

LOCKHART, W. R. *Dissertation Abstr., 15,* 190-1 (1955).

The behavior of cultures streaked on media already contg. a large no. of its own viable cells suggests that competition for available nutrients between organisms is the explanation of staling.

Use of membrane filter technic to enumerate enterococci in water.

SLANETZ, L. W., BENT, D. F., AND BARTLEY, C. H. *Public Health Repts., 70,* 67-72 (1955).

With this membrane filter technic, the counts for enterococci were generally higher than those obtained by other procedures. The method affords a relatively simple and direct means for the detn. of the nos. of enterococci in H_2O or in other materials.

NUTRITION

Biochemical and nutritional effects of lysine-reinforced diets.

ALBANESE, A. A., HIGGONS, R. A., HYDE, G. M., AND ORTO, L. *Am. J. Clin. Nutrition, 3,* 121-8 (1955).

The results of these studies bear the implication that the nutritional value of many infant foods, including cow's milk, can be substantially improved by small addns. of lysine.

The nutritive value of the proteins of beef extracted with different solvents, and of egg, milk and wheat germ for the growing rat.

CLARK, H. E., HOOPER, A. S., AND MCCORD, M. L. *J. Nutrition, 55,* 63-79 (1955).

The nutritive value of beef for growing rats may be reduced markedly by simultaneous dehydration and defatting with ethylene dichloride or propylene under certain conditions. The availability of methionine was decreased significantly by such treatment. Growth was improved by adding methionine or cystine. This reaction is peculiar to beef since the same procedure has been shown to exert no deleterious effect on several other proteins. From the nutritional standpoint, ether, heptane, and trichloroethylene were satisfactory solvents.

The effect of fat level of the diet on general nutrition. XIV. Further studies of the effect of hydrogenated coconut oil on essential fatty acid deficiency in the rat.

DEUEL, H. J., ALFIN-SLATTER, R. D., WELLS, A. F., KRYDER, G. D., AND AFTERGOOD, L. *J. Nutrition, 55,* 337-46 (1955).

The effect of the addn. of hydrogenated coconut oil (I) to the otherwise fat-free diets of rats has resulted in the depletion of essential fatty acids in a shorter time interval and at a lower animal wt. than when the rats were fed a fat-free diet alone. However, the continued presence of I in the diet had no apparent inhibitory effect on the subsequent response of the animal to linoleate although the animals depleted with I in the diet had a greater growth potential than the animals depleted on the fat-free diet. In rats receiving diets deficient in essential fatty acids, there was an increased cholesterol content in the plasma after one week. However, although the condition was further aggravated thereafter in the animals on the fat-free diets, cholesterol levels of the rats receiving I in the diets gradually returned to normal. This effect may be due to the availability of short-chain fatty acids contained in the hydrogenated fat for esterification of cholesterol.

Newer concepts of the role of fats and of the essential fatty acids in the diet.

DEUEL, H. J. *Food Research, 20,* 81-91 (1955).

Nutritional indices are discussed which indicate that fats and essential fatty acids are required for proper nutrition. 74 references.

High vegetable fat diet in diabetics with extensive vascular disease.

KINSELL, L. W., MICHAELS, G. D., AND FOREMAN, N. *Geriatrics, 10,* 67-71 (1955).

High vegetable lipid diets predictably will produce a normal plasma cholesterol in diabetic patients and other individuals with hypercholesterolemia. This effect, in some instances at least, appears to be assocd. with improvement in vascular status, with particular reference to retinal pathology. To date no evidence of favorable modification of renal pathology appears to have resulted from the use of this diet *per se.*

The nature of the creatinuria of nutritional muscular dystrophy in the rat.

DINNING, J. S. *J. Nutrition, 55,* 209-15 (1955).

Nutritional muscular dystrophy was induced in rats by the feeding of a diet deficient in both vitamins E and B_6. It is con-

(Contniued on page 22)

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SELECTED ABSTRACTS

(Continued from page 20)

cluded that the creatinuria which accompanies nutritional muscular dystrophy in the rat is the result of an inability of the muscle to retain creatine after its incorporation.

Studies on the effect of sodium bisulfite on the stability of vitamin E.

MILLER, R. F., SMALL, G., AND NORRIS, L. C. *J. Nutrition, 55,* 81-95 (1955).

The results showed that actively developing oxidative rancidity in unsatd. fat is directly concerned in the destruction of vitamin E and indicated that one of the functions of the vitamin is the maintenance of the integrity of unsatd. fatty acid mols.

A simplified nutrition program for the latter half of life.

MCCAY, C. M. *J. Am. Geriat. Soc., 2,* 417-21 (1954); *Biol. Abstr., 29,* No. 3568 (1955).

New evidence is presented that milk diets are useful for older people because they lead to stronger bones and better preserved teeth. When sugar is dissolved in milk and drunk in this soln. the teeth are protected against decay but milk does not protect teeth against either solid sugar or water solns. of sugar if these are consumed separately from the milk. An improved technic for the study of over-wt. in exptl. white rats was found in as much as such animals fed sucrose dissolved in whole milk become over-wt. early in life, maintain this over-wt. condition until they die in old age and die prematurely.

Pyruvic acid metabolism in obesity.

PENNINGTON, A. W. *Am. J. Digest. Diseases, 22,* 33-7 (1955).

Controlled expts. on the relative efficiency of carbohydrate, fat and protein in wt. reduction diets indicate that obese people lose more wt. when most of the cals. are derived from fat. These findings are explained by a concept of obesity as due to an impairment in the oxidative pathway of pyruvic acid. Recent advances in the biochemistry of pyruvic acid are reviewed and an attempt is made to identify the precise point at which the metabolic defect occurs. Implications in treatment are mentioned. 36 references.

Does a low intake of calcium cause or promote the development of rickets?

WALKER, A. R. P. *Am. J. Clin. Nutrition, 3,* 114-20 (1955).

While there seems to be no evidence that a low Ca intake promotes, still less causes, rickets, the possibility that level of intake has a modicum of etiological significance cannot be completely excluded. It would seem wholly unwarrantable, however, to list prophylaxis against rickets as a reason for insisting on the high intakes of Ca at present recommended.

PHARMACOLOGY AND TOXICOLOGY

Comparative effects of dietary fat and dextrin on mineral oil toxicity in the mouse.

ERSHOFF, B. H., AND GREENBERG, S. M. *Am. J. Digest. Diseases, 21,* 363-5 (1954).

Immature male mice were fed a purified low fat ration supplemented with mineral oil at levels of 5%, 7.5% and 10% of the diet. The higher 2 levels of mineral oil resulted in a marked retardation of growth and the occurrence of alopecia. Supplements of cottonseed oil or hydrogenated coconut oil at a 10% level in the diet significantly increased the wt. increment of immature mice fed a low fat ration contg. 7.5% mineral oil. These supplements decreased but did not prevent the attendant alopecia. Substitution of white dextrin for dextrose as a source of dietary carbohydrate in the low fat ration not only counteracted the growth-retarding effect of mineral oil but prevented alopecia as well.

Non-deleterious effects of polyoxyethylene esters in the nutrition of rats and cats.

KREHL, W. A., COWGILL, G. R., AND WHEDON, A. D. *J. Nutrition, 55,* 35-61 (1955).

Polyoxyethylene mono- and di-stearates, mono- and di-oleates, and mono- and di-laurates were fed to groups of rats at a level of 6% of the diet. Polyoxyethylene-8-monostearate (Myrj 45) was fed to rats and cats at levels of 10% and 20% of the diet, resp. The polyoxyethylene moiety of Myrj 45 was fed to rats at a dietary level of 6%. These expts. were of the long-term type extending over 1.5 years for the rats and over 1 year for the cats. There were no significant differences between the groups fed the control diets and those given the same diets supplemented with these various polyoxyethylene esters.

PHYSIOLOGY AND MEDICINE

Deranged cholesterol metabolism and its possible relationship to human atherosclerosis: a review.

FRIEDMAN, M., ROSENMAN, R. H., AND BYERS, S. O. *J. Gerontol., 10,* 60-85 (1955).

An extensive review from the limited point of view stated in the title. 194 references.

Extraction, isolation, and identification of hydrolytic products of triglyceride digestion in man.

BLANKENHORN, D. H., AND AHRENS, E. H. *J. Biol. Chem., 212,* 69-81 (1955).

Methods by which lipides are quantitatively extd. from intestinal contents and further sepd. into fatty acid, bile acid, and mono, di- and triglyceride fractions are described. Samples of intestinal contents have been aspirated from two healthy human subjects after test meals contg. defined fats, and the various products of fat hydrolysis have been isolated. Diglycerides have been positively identified for the first time as components of intestinal contents during fat digestion in human subjects.

The role of alkaline phosphatase in intestinal absorption. III. The effects of various fatty acids on levels of the enzyme in intestinal mucosa.

DICKIE, N., ROBINSON, M. I., AND TUBA, J. *Can. J. Biochem. Physiol., 33,* 83-8 (1955).

These findings indicate that further consideration should be given to the role of phospholipids in absorption of fatty acids.

ENGINEERING AND PLANT EQUIPMENT

The use of compressed air in food processing. Part 4.

SLADE, F. H. *Food, 24,* 93-9 (1955).

The last of this series of articles describes a few of the wide applications of compressed air at Casby Hall, the Hammersmith, London, factory of J. Lyons & Co. Ltd.

FOOD AND FOOD TECHNOLOGY

CEREALS AND GRAINS

Developments to date in electrostatic separation applied to grain.

AKE, J. E. *Am. Miller, 83,* 26-34, January, 1955.

A low-cost electrostatic separator is developed and described in detail. A process flow sheet is included.

COCOA

The quality of raw cocoa as it affects the manufacturer.

WADSWORTH, R. V. *Trop. Agr.* (Trinidad), *32,* 1-9 (1955).

Attributes of good cacao are discussed as are the defects to be avoided when cocoa beans are purchased or strains selected for propagation.

FATS AND OILS

The chemical composition of cacao butter bloom.

EASTON, R., AND MOLER, E. S. *Zucker-u. Susswarenwirtsch., 7,* 261-2 (1954); *Food Sci. Abstr., 27,* No. 455 (1955).

It was found that this fat "bloom" has an I value lower than that of ordinary cacao butter. Solidification point capillary m.p., I no., acidity, and saponification no. were established. The data are tabulated. They show that fat bloom is made up of some of the constituents, of cacao butter with higher m. ps. The compn. of cacao butter in mole-percentages is tabulated.

Present status of the foreign fat detection problem.

KEENEY, M. *Ice Cream Trade J., 51,* 20°, February, 1955.

Discusses the detection of foreign fats in ice cream.

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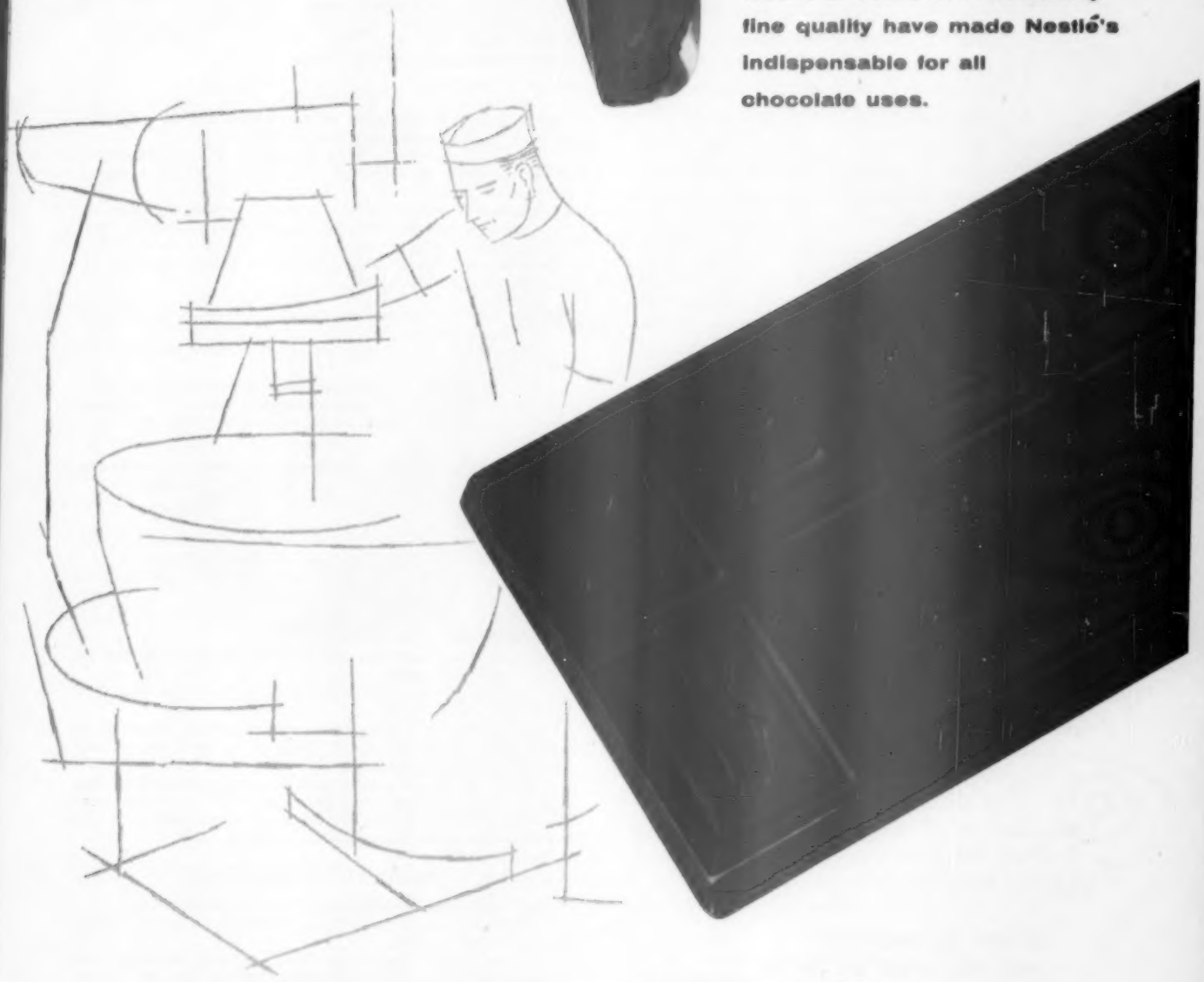

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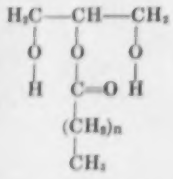

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SELECTED ABSTRACTS

(Continued from page 22)

MILK AND MILK PRODUCTS

The cavitation theory of homogenization.

McKillop, A. A., Dunkley, W. L., Brockmeyer, R. L., and Perry, R. L. *J. Dairy Sci., 38,* 273-83 (1955).

The results reported do not support either the cavitation or the impact theories of homogenization.

Stabilizers and ice cream quality.

Moss, J. R. *Ice Cream Trade J., 51,* 22°, January, 1955.

Compares the commonly used ice cream stabilizers, namely, gelatin, locust bean gum, Irish moss ext., sodium carboxymethylcellulose, algin and algin derivs.

POTATOES

Potato flakes. A new form of dehydrated mashed potatoes. I. Pilot plant process rising double drum drier.

Cording, J., Williard, M. J., Eskew, R. K., and Edwards, P. W. *USDA Circ.* ARS 73-2; *Am. Potato J., 32,* 35, January, 1955.

The new product can be rapidly converted to mashed potatoes by addn. of either H_2O or milk. The whipped product has the texture and color of freshly mashed potatoes and the flavor of baked potatoes. Com. development must await completion of storage tests and cost ests.

Factors associated with potato texture. I. Specific gravity and starch content.

Bettelheim, F. A., and Sterling, C. *Food Research, 20,* 71-80 (1955).

Sp. gr. and starch content of new tubers were significantly correlated with texture scores on boiled potatoes. No relationship could be found between chem. nature of starch and potato texture.

Potato quality. IX. Use of sequestering agents in preventing after-cooking darkening in pre-peeled potatoes.

Grieg, W. S., and Smith, O. *Am. Potato J., 32,* 1-5, January, 1955.

A 60 sec. dip in a mixt. of 1% $NaHSO_3$ and 1% sequestering agent effectively prevented after cooking darkening of pre-peeled potatoes when there was a lag of 24 hrs. or more between time of treatment and time of cooking.

STARCHES

The condition of the milk and its effect on the thickening capacity of starch.

Dorner, H. *Starke, 3,* 191-3 (1951); *Food Sci. Abstr., 26,* No. 3043 (1954).

It was found that the thickening capacity of wheat starch did decrease with increase in acidity of the milk; but no such effect was observed with milo starch, while the thickening power of maize starch was greater when sour milk was used in place of fresh milk. These expts. demonstrate that sour milk alone cannot be responsible for the failure of starch puddings to set. It was also found that sugar has no special effect.

ORGANIC CHEMISTRY

Light scattering investigation of potato amylopectin.

Witnauer, L. P., Senti, F. R., Stern, M. D. *J. Polymer Sci., 16,* 1-17 (1955).

Potato starch dispersed in H_2O at 90° and fractionated with mixed pentanols gave an amylopectin I having a wt.-av. mol. wt. of 36 million. Dispersion of starch by autoclaving at 120°, followed by nitrobenzene pptn. of amylose, yielded an amylopectin II with wt.-av. mol. wt. of 14 million. No evidence was found for dissocn. of these amylopectins into smaller units in aq. soln. at concns. as low as 10^{-4} g./ml., at elevated temps., or in NaOH solns.

Theogallin as a galloyl ester of quinic acid.

Cartwright, R. A., and Roberts, E. A. H. *Chemistry & Industry,* 230-1 (1955).

The presence in tea-leaf of a new polyphenol, theogallin, was recently described. The view that theogallin is a galloyl ester of quinic acid is supported.

(Continued on page 26)

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SELECTED ABSTRACTS

(Continued from page 24)

PACKAGING

The Chapman printing smoothness tester. I, II, and III.

CHAPMAN, S. M. *Tappi, 38,* 90-114 (1955).

Printing smoothness may be defined as fraction of the surface brought into contact with a smooth surface pressed against it under pressures comparable to printing pressures. The Chapman Tester measures this property. Three papers are presented. I. Basic developments and modification. II. Instrument variables and results. III. Design and use of a direct reading tester.

Studies in water-in-oil emulsions. IV. The influence of the emulsifying agent on the viscosity of water-in-oil emulsions of high water content.

SHERMAN, P. *J. Colloid Sci., 10,* 63-70 (1955).

It is concluded that the chem. constitution of the emulsifying agent does not affect the resultant emulsion viscosity, presumably through the phys. state of the film formed at the interface and its relationship to the 2 phases.

The viscosity of suspensions of spheres.

ORR, C., AND BLOCKER, H. G. *J. Colloid Sci., 10,* 24-8 (1955).

Particle size distribution often suggested as a factor influencing the viscosity of suspensions, is considered quantitatively. By an analysis of previously reported data, the viscosity of suspensions of spheres from the lowest to the highest concn. is shown to be described in terms of the viscosity of the pure liquid, the vol. fraction of solids, the packed sediment vol. of solids, and the geometric standard deviation for the solids.

PHYSICAL RESEARCH

The rate of evaporation of water through fatty acid monolayers.

ARCHER, R. J., AND LAMER, V. K. *J. Phys. Chem., 59,* 200-8 (1955).

The data are reported as the specific resistance of the monolayer to evapn. which is equal to the reciprocal of the specific rate const. for condensation through the film. These data establish a contamination effect upon which the retardation of evapn. is strongly dependent and which has introduced serious error in all previous work.

An apparatus for measuring the elastic properties of gels.

HASTEWELL, L. J., AND ROSCOE, R. *J. Sci. Instr., 32,* 96-9 (1955).

A simple app. is presented which can be used to obtain dynamic rigidity and dynamic viscosty of gels. A math. soln. is demonstrated for the theory of operation of the app.

POLYMER RESEARCH

Diffusion of water vapor in polymers.

LONG, F. A., AND THOMPSON, L. J. *J. Polymer Sci., 15,* 413-26 (1955).

Data are presented on the rates of sorption and desorption of H_2O vapor into films of several linear polymers with emphasis on a study of the concn. dependence of the diffusion coeff. and on the extent of agreement of the results with Fick's laws of diffusion. The polymers studied were polyvinyl acetate, cellulose acetate, cellulose nitrate, 6-10 nylon and polyvinyl alc.

The degradation of cellulose by ionizing radiation.

CHARLESBY, A. *J. Polymer Sci., 15,* 263-70 (1955).

Cellulose is rapidly degraded into a powdery material when subjected to the effect of ionizing radiation, such as atomic pile radiation or γ radiation. It is deduced from intrinsic viscosity measurements that 1×10^6 r. results in fracture of 0.16% of the monomer units. One monomer unit is also decomposed per main chain fracture.

WATER, SEWAGE AND SANITATION

Symposium on ion exchange in water and waste treatment.

Ind. Eng. Chem., 42, 46-101 (1955).

Titles include: Hydrogen exchange resin for steam purity testing. Electrodialysis of water using a multiple membrane cell. Concentration of radioactive aqueous wastes. Electrolytic regeneration of spent pickling solutions. Phenol sorption on ion exchange resins. Anion exchange removal of iron from chloride solutions. Cation exchange removal of radioactivity from waste. Treatment of chromic acid wastes, evaluation of methods. Treatment of spent sulfuric acid pickling liquors. Monobed operation with a problem water. Capacity and leakage of ion exchange columns.

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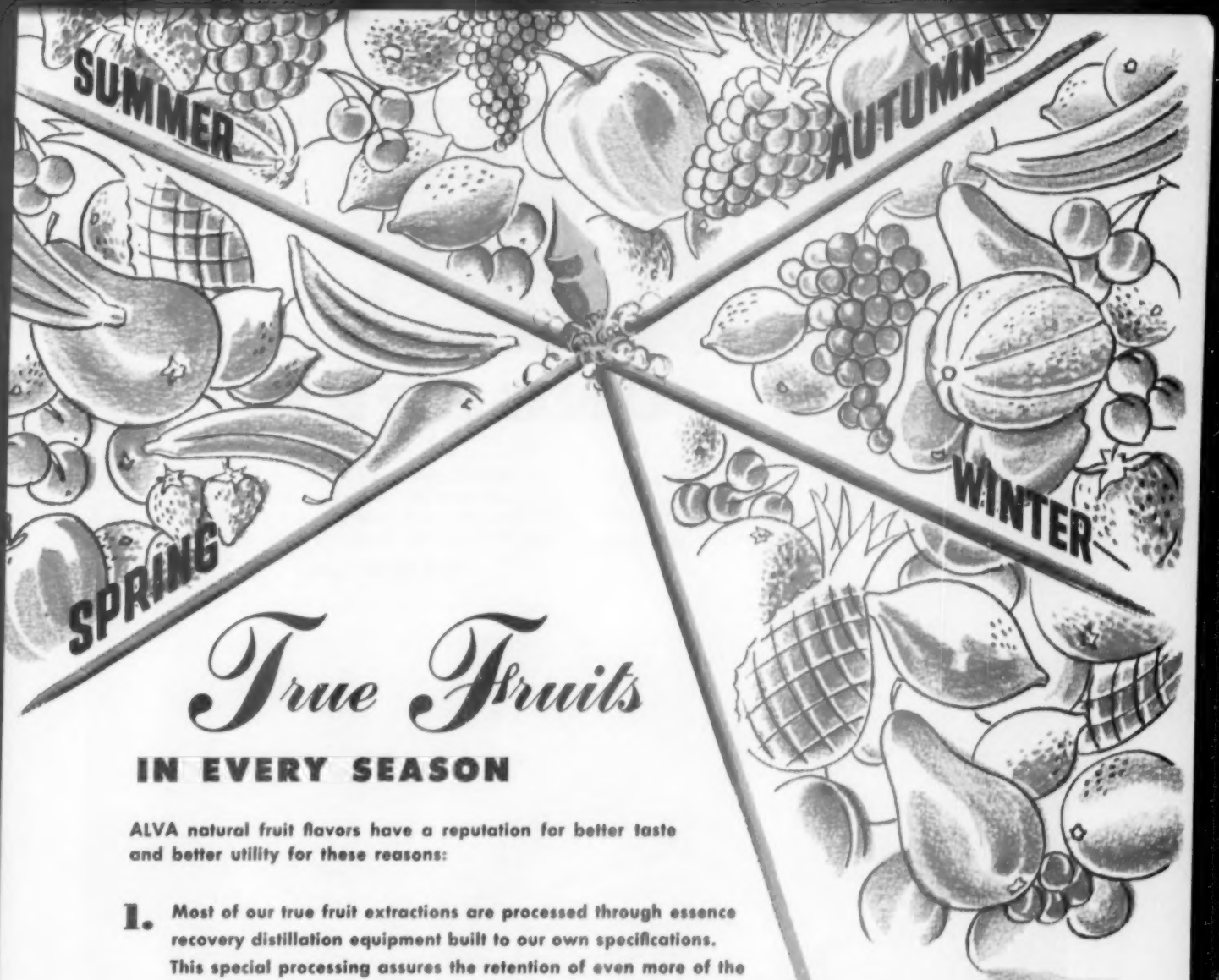

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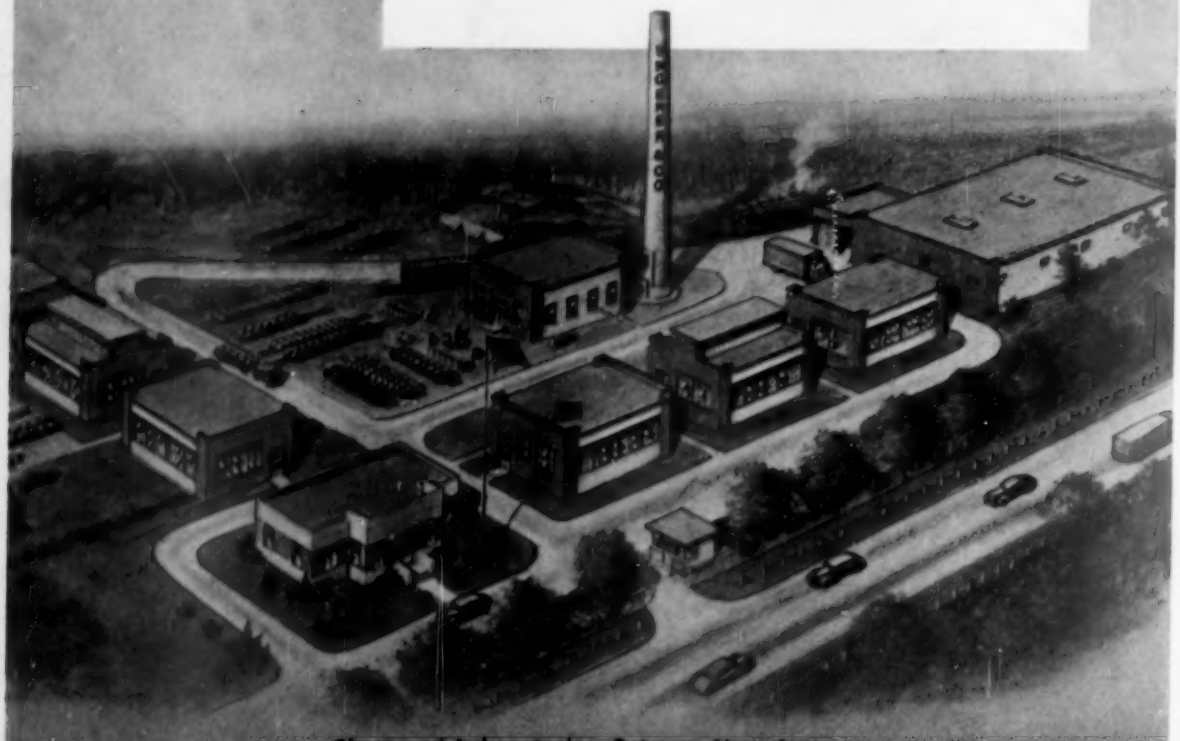

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Present Needs for Special Purpose Foods in Medical Diets[a]

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(Manuscript received March 4, 1955)

In order to warrant the attention of food technologists, medical diets must be those that are utilized consistently and on a reasonable scale. It seems quite obvious that certain diets, though they may have a definite and unchallenged place in our therapeutic armamentarium will never be widely enough used to acquire or deserve the luxury of special purpose foods. Examples would be the low purine diet for gout or a low calcium diet for certain types of kidney stones. Other diets excite sufficient difference of opinion among the medical profession or are on such a questionable basis as not to warrant any large investment by the food industry in special purpose foods. Examples are the low cholesterol diet in atherosclerotic disease or the gluten-free diet in sprue.

There are a few dietary modes of therapy that are established on a sound basis, have wide application, and a firm future. The medical profession needs and appreciates help in making these diets available to their patients. Since the results of dietary therapy are rarely dramatically evident to a patient, in order for him to adhere to it over a prolonged period the proper foods must be easily available to him, must not decimate his pocketbook nor insult his palate.

FORMULATING A DIET FOR DIABETICS

The diet most strongly established and with the widest use at the moment is that for the diabetic patient. It is virtually the unanimous opinion of the medical profession that careful balancing of the food intake and insulin dosage to prevent hyperglycemia and glycosuria is rewarding in reduction of the degenerative complications of diabetes. The "eat-what-you-wish" school is certainly in the small minority; in my opinion the only justification for this approach is economic necessity or lack of intelligence on the part of the patient. There is a tendency towards increased use of carbohydrate, provided it is properly balanced with insulin, towards increased consumption of protein and away from the high fat intakes of prior days. There is no great problem in constructing a diabetic diet from presently available foods. There is, however, a considerable problem in getting the patient to adhere to this diet, and the key to the successful handling of a diabetic, particularly when relatively large amounts of insulin are being used, is regularity—both in the type and amounts of food eaten. Diabetics wish to live like ordinary people; they do not want to be singled out by peculiarities in the food they eat. They don't want to be denied things; if they are, even the most cooperative ones will kick over the traces occasionally. A good share of them were heavy eaters before they ever developed diabetes, and even with a very liberal carbohydrate allotment they find it hard to cut down their food consumption to the required level.

So the problems in the dietary control of diabetes then are threefold:

1. The diabetic must know the nutritive content of the food he is eating—in order for him to keep his food intake constant from day to day.
2. He must not be denied too many specific foods—or he may develop a neurosis, or rebel against medical authority.
3. He must be able to eat a reasonable quantity—or there will be a tendency for him to cheat on his diet.

The food industry has helped tremendously with these problems. There are becoming available more and more canned goods with composition and calory labelling. Calory labelling is of great value to the diabetic in assisting him towards his goal of a constant daily food intake. This information, in a general way, is available to the diabetic in various food tables and books. But it is made simpler, more specific, and thus more practical if it is present right on the can.

I realize that accurate composition and calory labelling is difficult. There are differences of opinion about the best way to compute food energy values and it is probably true that no two people utilize an ingested food to the same degree and in the same manner. However, a reasonable approximation is quite good enough for the diabetic.

I see no reason to limit calory labelling to specially prepared foods. Other canned goods of moderate caloric content could be advantageously so labelled even though they are not designed specifically for the diabetic. A small increase in price would be justifiable, I think, for this service.

The problem of specific food denial, particularly carbohydrate foods, has been helped by a recent development. The discovery of a calory-free sweetening substance, Sucaryl, that will withstand baking temperatures without destruction, will be an aid in many dietary foods. It achieves a good imitation of the sugar taste and therefore provides for the diabetic canned fruits in syrup, various other desserts, soft drinks, and numerous other items. The possibility that toxic reactions may appear, however, must still be considered. I expect to see increasing numbers of Sucaryl-containing preparations, and I think there will be a market for them.

Special purpose foods for the diabetic are still too expensive, and further variety of Sucaryl-containing preparations is desirable. Of particular value would be a low calory substitute for flour which would allow the consumption of more bread and pastries.

A complaint of many diabetics is their inability to purchase a satisfactory restaurant meal. Only those patients with intelligence and a lot of training can be expected to adequately evaluate restaurant meals with respect to their own diet. Restaurants should be encouraged to use calory labelling on parts of their menus or cafeteria shelves as a convenience to diabetic patrons. This would be of double value, providing a needed service for the diabetic and a boon for the food manufacturer who would obtain a ready-made market for his special purpose foods.

CONSIDERATIONS IN PRESCRIBING DIETS FOR OBESITY

A diet with even wider potential application, but by the very nature of the problem less utilized, is that for weight reduction in obesity. Everyone agrees that certain diseases are more common in people who are over-weight. Hypertension, coronary disease, and diabetes are examples. It is widely assumed that weight reduction will lessen the likelihood of acquiring these disorders or decrease their severity once acquired. Personally,

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California, June 28, 1954.

I think this is far from proven. It may well be that the person who is genetically fated to be obese is likewise genetically fated to have these diseases. There is nothing definite to indicate that it is the obesity itself that brings on the difficulty. Nevertheless, I think, weight reduction diets are here to stay, and it will be a number of years at best before anyone can untangle the problem as of whether obesity is the cart or the horse.

Most obese people have some desire, albeit a small one, to lose weight. This is evidenced by the tremendous sales of nostrums that fill our drug store shelves. But many obese people are gourmets of the highest calibre, and this is the problem that it seems to me the food industry can help us manage.

One approach is to reduce appetite by filling the stomach with such a substance as methyl cellulose, which is the main ingredient of many of the reducing pills. This does fairly effectively cut appetite, but I doubt if any real results can be obtained over a long term period by this technique. We do not yet have any drug with a specific action on the appetite center of the brain and no distressing side effects. There is no immediate prospect of finding one.

I think that the most effective approach will be to deceive the gustatory sense with palatable but relatively non-metabolizable low calory substances. Calcium cyclamate appears to have solved the problem as far as sugar is concerned. Of great importance would be similar types of substitutes for some of the fatty foods—butter, cream, salad dressings, cooking oil, etc. A substitute for flour would solve a lot of problems. The manufacturer who comes forward with really good products of this sort will be amply rewarded financially, I believe.

All of these low calory substitutes need not be synthetic materials. Some times there are variants of natural foods with a lower calory content that can be selected or that can be manufactured with a minimum of effort. Skim milk is an example. Its sales are increasing all the time and probably will continue to do so.

Increased calory labelling of foods both on the grocery shelves and in the restaurant would provide an "assist" to the reducing diet and a boost to the sale of low calory preparations.

THE LOW SODIUM DIET

The third diet I would like to mention is the low sodium diet. I think there is probably no parallel in medicine where we can blame so much difficulty in so many different diseases on one specific dietary constituent. The chief symptoms in heart failure, cirrhosis of the liver, kidney nephrosis, and toxemia of pregnancy are related to the retention of sodium and edema fluid in the body. This edema fluid retention can be almost completely eliminated by the removal of sodium from the diet. Fortunately, it is safe in nearly every instance to give a diet practically sodium free. It is true that we have powerful diuretic drugs that will remove sodium and edema fluid, but we are not entirely certain that these agents are without bad effects on the body. It seems more reasonable not to rely entirely on these drugs, but to prevent edema formation by a restricted sodium intake.

Another use for the low sodium diet is in the treatment of high blood pressure. Marked sodium restriction is sometimes effective by itself in the treatment of high blood pressure, and it nearly always assists any other type of therapy we choose to apply. The relationship between sodium and hypertension is certainly a real one, but we are far from knowing the intimate details.

The food industry has been very helpful in the development of low sodium products. An adequate low sodium diet would be almost impossible, and certainly impractical, without them. A number of years ago when the low sodium diet was first employed on a wide scale the choice of foods was so limited that a diet consisting solely of rice and fruit was used. Now we have a large selection of canned goods, low sodium butter, low sodium bread, and within the last year even a satisfactory low sodium milk.

But there are still problems. All of these items are quite expensive, some of them are only available in health stores, many of the usual canned goods are still not available, and it has so far proved impossible to make satisfactory items like sauces, meat products, and salad dressings. The most important step forward has yet to be taken and that is to find some non-toxic substitute that tastes like salt. There would be no problem if such a substance could be found. Present salt substitutes, in my opinion, are hardly worthy of the name. The best one yet discovered, lithium chloride, proved to be toxic in some instances and had to be withdrawn from the the market several years ago.

I have no doubt that as the public becomes more and more medically conscious the use of special purpose foods will increase. In the meantime the problem of the food industry is not as much the development of new foods as it is the sale of those foods it already has. These products need advertising. Most doctors are not well trained in, or particularly interested, in, diet. Hence, they are not of much help. Advertising directly to the consumer is somewhat handicapped by the problem of ethics. But the need for some form of advertising is apparent. Only a small percentage of patients on special diets know about what foods are available. They gradually discover items here and there as they go along.

This problem, at least in the case of low sodium diets, has been partially solved locally (Los Angeles) by a committee of the Heart Association—a group of interested doctors whose function is to stimulate the development of new products, disseminate information, and to place the Heart Association's seal of approval on food products that meet their specifications. Lists of available foods with brand names, specifications, and sources of local supply are published annually for distribution by doctors to their patients.

A SUGGESTION FOR THE FOOD INDUSTRY

I would favor some such central clearing house of information for the other accepted types of special foods. This could take the form of a journal supported by the food industry, supervised by an interested medical committee, and distributed widely to dietetically treated patients. Rather than on a nationwide basis this function might be performed better on a local level. This would stimulate smaller manufacturers to enter the special food market. Labelling of foods is more accurate if samples from one area are analyzed. Information as to local sources of supply is very important to the consumer.

In conclusion I would like to emphasize that in my opinion the medical profession is most anxious to insure the food industry reasonable profit on their special food ventures. By this means we hope to increase research and development of needed new products, to lower costs to the consumer, and to eliminate unethical food faddist profiteers.

The Effect of Various Factors on the Drained Weight of Canned Red Cherries[a]

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(Manuscript received March 18, 1955)

Drained weights are not affected either by soluble solids content or by time and temperature of soak, but varied with relation to areas and years and with weather conditions. Small amounts of sugar, dry or sirup, gave higher drained weights and better quality without increasing cost.

Although drained weight is not incorporated in the grades for canned red cherries, it is important because of its relation to the yield of the processed fruit. Variations in drained weight have been commonly attributed to differences in growth conditions as they affect the size of the fruit and its total solids content, to handling practices such as soaking time and temperature and to variations in spray treatments. Bedford and Robertson *(1)* found no significant differences in drained weights between spray treatments, orchards or years during the seasons of 1949, 1950 and 1951, although copper sprayed cherries averaged slightly higher drained weights. These results were similar to those reported by Langer and Fisher *(6)* and Swingle *(8)*. It has also been suggested that there is a relationship between soluble solids content of the cherries and drained weights, although Whittenberger *(11)* found no relationship. Whittenberger also reported that drained weight was associated with a higher degree of tissue cohesiveness and that post-harvest aging, bruising combined with aging, and treatment with calcium ions increased drained weight.

This report summarizes the results obtained during the past five years on the effect of area, year, soaking time and temperature, soluble solids content, put-in-weight and method of packing on the drained weights of processed cherries.

EXPERIMENTAL METHODS

Montmorency cherries grown and harvested commercially in the various cherry growing areas of Michigan were used. The cherries were transported by truck to the Michigan State College Food Technology laboratory and on arrival were weighed and placed in soaking tanks or stored at 2° C. (35° F.). Representative lots were removed at various intervals, drained and pitted in a Dunkley cherry pitter of pilot plant capacity. The pitted cherries were canned in No. 2 cherry enamel cans. For the studies on the effects of area, year and soaking time and temperature, 16 ounces of cherries were filled into each can, covered with hot water, exhausted, processed in boiling water for 12 minutes, cooled and stored at 10° C. (50° F.). To determine the effect of put-in weight and packing medium, 14 to 17 ounces of cherries were filled into each can, covered with hot water or sirup, and processed as above. The sirup packs included both straight sucrose and mixtures in which 20 and 30% of the sucrose solids were replaced by dextrose or corn sirups (dextrose equivalents of 54 to 63%).

After 4 to 6 months the canned cherries were removed from storage and allowed to reach room temperature, 20°-21° C. (68°-70° F.). Then, the drained weights and soluble solids content of the canned cherries were determined.

Soluble solids were determined on the fresh, soaked and canned fruit with an Abbe refractometer. Drained weights were determined according to the U. S. Standards for Grades of Canned Red Sour (Tart) Pitted Cherries *(9)*.

RESULTS

Soluble solids and drained weight. There was no relationship between the soluble solids content of the fresh or soaked cherries and the drained weight of the canned fruit. The results obtained from the examination of over 500 cans gave a correlation coefficient of .005. The soluble solids content of the cherries prior to canning ranged from 10.9 to 18.4% and the drained weights varied from 13 to 15 ounces with a put-in weight of 16 ounces.

Cooling time and temperature. The drained weights of canned cherries from similar lots of fresh cherries soaked for different lengths of time and at different temperatures were similar (Table 1). These results indicated that the time and temperature of soaking had no effect on the drained weights. It must be pointed out, however, that soaking at the lower temperatures is more desirable for the retention of quality.

TABLE 1

Influence of time and temperature of cooling on drained weights of canned Montmorency cherries[1]

Time of soaking	Temperature of soaking, ° F.			Average	Air cooled 35° F.
	57°	42°	35°		
Hours	Drained weight, ounces				
0	14.0	14.1	14.0	14.0	14.0
6	14.0	14.0	14.0	14.0	14.0
12	14.0	14.0	14.1	14.0	14.2
24	13.9	13.9	14.2	14.0	14.3
36	14.0	14.0	.....	14.0	.....
48	13.8	13.7	.....	13.8	14.3
	14.0	14.0	14.1		

[1] Put-in weight 16 ounces.

The drained weights of the cherries cooled in air for 12 hours at 2° C. (35° F.) were higher than those cooled in air for 0 and 6 hours prior to processing. Further storage time did not result in a significant increase in drained weight. Whittenberger *(11)* reported that the drained weight increased steadily with the time of storage prior to processing, extending from 0 to 101 days.

Effect of area and year. The results are summarized in Table 2. The drained weights of the cherries obtained from northern Michigan were significantly lower than those of southern Michigan in 1952 and 1953 and significantly higher in 1949 and 1954. The lower drained weight obtained for the southern Michigan cherries in 1949 may be attributed, in part, to the size of the fruit. Because of a small crop, the cherries

[a] Journal Article No. 1734 from Michigan Agricultural Experiment Station, East Lansing.

TABLE 2

Influence of area and year on drained weights of canned Montmorency cherries [1]

Area	Drained weight, ounces						
	1949	1950	1951	1952	1953	1954	Aver.
Southern Michigan	13.5	14.0	14.0	14.1	14.1	13.5	13.9
Northern Michigan	13.9	14.0	14.0	13.6	13.9	14.2	13.9
Average	13.7	14.0	14.0	13.8	14.0	13.8	
Difference required—5%	.20	.....	.....	.17	.15	.12	.....
between areas—1%	.27	.....	.....	.22	.....	.16	.....

Difference required between years—5% .14; 1% .18.
[1] Put-in weight 16 ounces.

were considerably larger than normal and it was almost impossible to pit the large fruit without extensive pitter damage and disruption of the cellular structure. This did not occur in subsequent years, and although no definite explanation can be given for the variations in drained weight in 1952, 1953 and 1954, there appeared to be a relationship between weather conditions during the growing season and the drained weights. The lower drained weights occurred whenever the rainfall was considerably higher than normal, particularly during the 3 or 4 weeks immediately prior to harvest, and when temperatures were nearly normal. This condition existed in northern Michigan in 1952 and 1953 and in southern Michigan in 1954. When the mean temperature was either considerably above or below normal, rainfall seemed to have little or no effect. Whittenberger *(11)* has suggested that high drained weight is associated with a high degree of tissue cohesiveness, which in turn, is dependent on the strength of the intercellular cement. On the basis of this concept, it would seem that under weather conditions of above normal rainfall and nearly normal temperature the intercellular cement in the cherries is either degraded or fails to strengthen.

Relation of put-in weight to drained weight (in various packing media). For the sake of brevity only the data from one area in 1954 is presented (Figure 1). Data obtained in previous years and from other areas showed similar relationships between the regression curves of the various packing methods.

The drained weights of the 20 and 30% and of the 40, 50 and 60% sirup packs, respectively, did not differ significantly and therefore are combined for presentation in Figure 1. The drained weights of the fruit packed in sirups in which 20 and 30% of the sucrose solids was replaced by either dextrose or corn sirups (dextrose equivalents of 54 to 63%) were also found to be similar to the straight sucrose sirup packs and therefore are not given separately.

Red cherries canned with the addition of one ounce of sugar per No. 2 can or in 20 or 30% sirups had higher drained weights than those water packed, although the differences were not significant. Those packed with 40 to 60% sirup had significantly lower drained weights than the other packs.

Relation of sirup concentration to juice cut-out. The relationship between the sirup concentration and juice cut-outs for the various put-in weights of cherries is shown in Figure 2. The results showed that the cherries packed with heavier sirups had lower concentrations of sugar in the sirups after canning than at the time of filling, while those packed in 15% or lower sirups had cut-outs higher than that of the original liquid. The cherries used in this study had an average soluble solids content of 15.2% and it would be expected that cherries with either higher or lower soluble solids would either raise or lower the juice cut-outs. Hartman and Bullis *(5)* found that each 1% increase in the sugar content of the cherries resulted in nearly a 1% increase in juice cut-out. The results obtained on water packed red cherries with a put-in weight of 16 ounces indicated a cut-out increase of about 0.6% for every 1% increase in the soluble solids content.

The put-in weight of cherries also had an effect on the juice cut-outs. With a put-in weight of 14 ounces of cherries, the juice cut-out increased about 4% for every 10% increase in the packing sirup concentration. This increase was reduced 0.5% for every 1 ounce increase in the put-in weight of cherries and with a put-in weight of 17 ounces was 2.5%. In both water pack and the pack with 1 ounce of dry sugar, the juice cut-out increased about 0.55% for each ounce increase in put-in weight. The juice cut-out ranged from 15.9 to 17.55% for put-in weights of 14 to 17 ounces for the sugar pack and from 10.8 to 12.7% for the water pack.

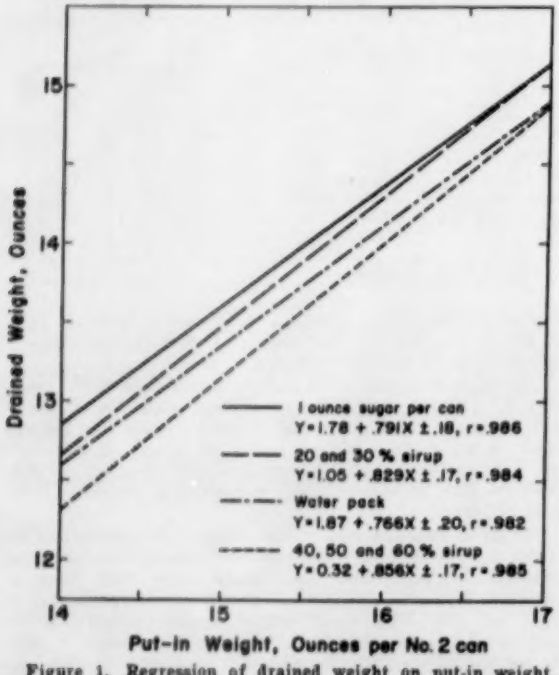

Figure 1. Regression of drained weight on put-in weight. Comparison of water, sugar and sirup packs.

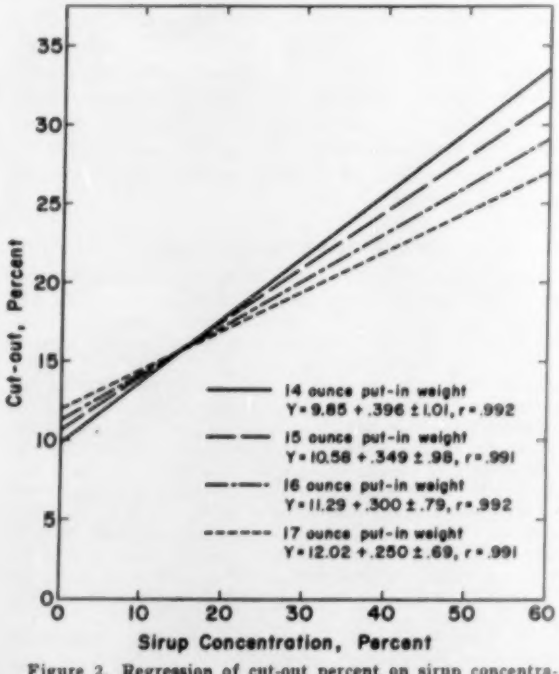

Figure 2. Regression of cut-out percent on sirup concentration with various put-in weights of red cherries.

Although the cut-out requirements for packing media are not incorporated in the grades of the finished product, they are used for standard of identity. Canned red cherries to which sugar or sugar sirup is added must be labeled to designate the packing media and these are based on the Brix of the cut-out juice *(9)*. From the data given it can be seen that cherries canned with either 1 ounce of dry sugar or with 20% sirup would have to be designated as packed in "slightly sweetened water" since the juice cut-out is less than 18% while those packed in heavier sirups would vary from "light sirup" to "extra heavy sirup," depending upon the sirup concentration used, the soluble solids content of the cherries, and the put-in weight.

Relation of sirup concentration to quality. It has been a common practice to pack cherries for dessert purposes in sirup and in water for pie stock. Therefore, most of the pitted red cherries are water packed.

Griswold *(4)* reported that Montmorency cherries packed in water compared unfavorably with those packed in 40 to 50% sirup in respect to palatability, brightness of color and texture. In our preliminary studies we found that the canning of red cherries with 1 ounce of sugar or in 20 or 30% sirup increased the firmness and brightness of the cherries and improved the palatability over those water packed, either as a dessert fruit or in pies *(2)*. Similar results were obtained in this study. It was also found that better palatability scores were obtained for cherries packed in 40 to 60% sugar sirups than in either the lighter sirups or water when the fruit was used as a dessert fruit. However, in pies, the palatability scores were not significantly different from those obtained with the lighter sirup packs and therefore the use of the higher sirup concentrations in cherries packed for pie stock is questionable when the cost is considered.

The sirup packs in which 20 and 30% of the sucrose solids were replaced by dextrose or corn sirup were as acceptable as those packed with straight sucrose. At higher replacement levels the quality was not considered as acceptable as at the lower levels and this became more pronounced as the sirup concentration was increased *(2)*. Van Arsdale and Eddy *(10)* found that equal parts of sucrose and dextrose make an acceptable sirup for canning cherries but that a sirup made from 3 parts of dextrose to one part of sucrose gave an unacceptable canned product. Fellers *et al. (3)* canned Montmorency cherries in 60% sirups and reported those packed in 2 parts of sucrose and 1 part of dextrose were acceptable while those in 3 parts of sucrose and 1 part of dextrose were preferred to all sucrose. Griswold *(4)* found that dextrose gave a product having weaker color and a poorer quality score than sucrose.

Since red cherries canned either in "slightly sweetened water" or in "light sirup" resulted in processed fruit that made more attractive and palatable cherry pies than the water pack, it would seem that these types of pack are worthy of consideration by the industry. It is realized that the addition of sugar or sugar sirup increases the production costs. However, on the basis of the data obtained this would be offset by the reduction in weight of cherries required per can. Referring to Figure 1, it can be seen that to meet the recommended drained weight requirement of 12¾ ounces for sirup pack a put-in weight of about 13.9 ounces of cherries are needed with 1 ounce of sugar and 14.1 ounces with 20 to 30% sirup, while in the water pack a put-in weight of about 15.2 ounces of cherries is required to meet the recommended drained weight requirement of 13½ ounces. Therefore, on the basis of a dozen cans and assuming an 80% yield of pitted cherries, the amount of fresh fruit required would be 19.5 or 16.5 ounces less, respectively, for the sirup packs and at 8 cents per pound would reduce the cost by about 9.75 and 8.25 cents, respectively, per dozen cans.

The cost of the sugar for the "slightly sweetened water" type pack, using 1 ounce of sugar per can, would be about 7 cents per dozen cans, assuming a sugar price of about $9.25 per hundred pounds. In the "light sirup" pack, the amount of sugar required is about 1.25 ounces per can (6.0 ounces of 21°F. sirup; see Figure 2), and the cost would be about 8.7 cents. Comparing these figures with those given above for the price of the cherries, it can be seen that the cost of the sugar is completely or nearly offset by the reduction in the cost of the cherries for the sugar sirup packs. Similar results were obtained for No. 10 cans. It is realized, of course, that the amount of sugar required for a light sirup pack will vary depending on the soluble solids content of the cherries. Cherries with lower soluble solids than those used in this study would require the addition of more sugar in order to meet the cut-out requirement and thus increase the sugar cost of this type of pack.

SUMMARY

There was no relationship between the soluble solids content or time and temperature of soaking and the drained weight of the cherries. The drained weights varied significantly between areas and years and this variation seemed to be related to weather conditions during the growing season. Lower drained weights were obtained under conditions of high rainfall and normal temperatures, particularly when these conditions occurred during the three- or four-week period prior to harvest.

Cherries canned with one ounce of sugar per can or in 20 or 30% sirup had higher drained weights than those packed either in water or in 40 to 60% sirups.

The juice cut-out varied directly with the soluble solids content of the fruit, the sirup concentration and the put-in weight of cherries. In the water pack the juice cut-out increased about 0.6% for each 1% increase in put-in weight. In the sirup packs the cut-out increase for each 1% increase in sirup concentration varied from 0.4 to 0.25% with put-in weights of 14 to 17 ounces of fruit.

Cherries packed in sirup had better quality, either as a dessert fruit or in pies, than those packed in water. The cost of packing cherries in either "slightly sweetened water" or "light sirup" would be less than or about equal to the cost of the water pack.

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Strawberry Preserves by a Low Temperature Process

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In this paper, equipment for concentrating a strawberry preserve to the desired solids content at temperatures of 90-95° F. is described. Losses in anthocyanin pigment may be held to a minimum. Data are presented showing that, as a result of storage, brown pigment arises either concomitantly with, or as a direct result of, anthocyanin degradation.

During the past four years, studies on the deterioration of strawberry preserves on storage have been conducted.[a] Sondheimer and Kertesz *(6)* analyzed the nature of the problem, showing there was loss of natural anthocyanin and formation of brown artifacts. The reaction rates were further studied by Meschter *(5)* and by the present investigators. Our studies emphasized the desirability of minimizing the heat treatment, both in lessening the loss of anthocyanin and in preventing development of brown artifacts. In an industrial survey, we had found, in agreement with results of Sondheimer and Kertesz, that strawberry preserves of satisfactory appearance might be expected to contain from 3 to 13 mg. pigment per 100 g. preserve. In only one case was a pigment content higher than 13 mg. found.

Depending on variety and maturity, the strawberry is endowed with *ca.* 35 to 55 mg. of anthocyanin per 100 g. fresh berries. Thus, allowing for changes caused by addition of sugar and by concentration, we encounter losses during preserve making ranging from at least 30 and up to 70% or more of the pigment initially present.

As a result of discussions at the annual meetings of the National Preservers' Association, the Department of Food Technology decided to have constructed a vacuum pan capable of effecting a rapid concentration of the preserve to the desired solids content in the temperature range 90 to 100° F. It may be stated, at this juncture, that certain anticipated difficulties have not as yet arisen. Sugar equilibration between berry and syrup is rapid, presumably because the berry structure has been weakened by freezing and subsequent thawing, and consequently there have been no "floaters" in the preserve. The equilibration is not however complete during the cook. The development of the color in the gel, reviewed recently by Mackinney and Chichester *(4)*, does not require an elevated temperature, as contended by some preservers. Finally, because there is no condensate, as the preserve is already cool, a simple vacuum in the headspace has so far been found adequate in preventing surface mold growth. Our analyses indicate that 90% of the natural pigment content may be retained in such a preserve, and we present in this paper a brief description of the equipment, some process times and temperatures, and analytical data on the products.

[a] Aided in part by the National Preservers' Association.

EXPERIMENTAL PROCEDURES AND DATA

Equipment. The achievement of low temperature evaporation depends upon the utilization of an efficient vacuum system. As no pilot scale equipment was available, a system for the preparation of low temperature preserves was constructed. As installed, the complete system consists of a batch evaporator, condenser, condensate receiver, and vacuum pumps.

The pan is a welded stainless steel (Type 316) cylinder 18 inches inside diameter with a removable top. Two steam-jackets are used, one surrounding the base and the wall to a height of 6 inches, the second a doughnut 6 inches high, separated from the lower jacket by 3 inches. Both jackets have separately controlled steam and water supplies. The total heating surface is approximately 8.2 sq. ft. The jackets may be operated at 60 lbs./sq. in. differential pressure. The space between heating surfaces is utilized for temperature measurement, and sampling. The pan is equipped with two sight glasses in the sides above the jackets, and a solids separator in the removable cap. The product is introduced by means of a 12-inch diameter manhole in the side of the cylinder, and removed through a 3-inch plug valve at the base. Height above the top jacket is 29 inches to allow room for foam breaking.

The condenser consists of a shell and tube exchanger, 10 feet long. The vapor is condensed on the outside of eighteen ¾-inch O. D. stainless steel tubes. The total condensing area is approximately 35 sq ft. Coolant flow is co-current and is fed from a 2 inch main at 80 p.s.i.g. Provision has been made to use a refrigerant as a coolant, when the ground water temperature is adjudged too high. With water at 78° F. as a coolant, condensation temperature is 94° F. at an evaporation rate of 380 lbs. of water per hour. The condensate is removed from the condenser by gravity and accumulated in a stainless steel reservoir of 10 gallons capacity.

Vacuum is maintained by a two-stage steam ejector, operated non-condensing. A steam pressure of 100 lbs./sq. in. gives a blank-off pressure of less than 0.3 lb./sq. in. When the system is operated with an evaporation rate of 45 gallons of water per hour, a vacuum of 29.5 inches of mercury or higher is consistently observed.

Experimental runs. Several preliminary runs were made before the equipment was brought to peak performance. The first run was made at a low jacket pressure (1-2 p.s.i.g.), and experience indicated the necessity of higher jacket pressures for a rapid cook. This particular run was a batch of 60 lbs., 3 + 1 Marshalls, to which sugar, pectin and acid were added, and the pre-cook solids content was 54%. Temperature of condensing water was 78° F. at the inlet, 81° F. at the outlet. Boiling point during the cook was 92° ± 2 F., at a vacuum of 29.3 in. and a jacket steam pressure of 1 lb. p.s.i.g. Time required was 13 minutes.

The batch was packed in 10 oz. glass jars and sealed with Anchor-Hocking caps under vacuum. One half of the jars received no further heat treatment, the other half was heated to 165° F. at the center, and then cooled. The data of Table 1 indicate a 20% loss in pigment in the berry and gel as a result of heating. Studies were conducted on the rates for pigment degradation and browning as measured by the optical density,

TABLE 1

Effect of heat on anthocyanin and browning in berries and gel, and on whole preserve

	Pigment mg./100 g.	Browning optical density at 440 mμ
Unheated		
Berries	20.8	0.188
Gel	13.0	0.073
Heated		
Berries	16.2	0.189
Gel	10.9	0.135
Whole Preserve		
Unheated	20.4	0.112
Heated	15.9	0.125
Original 1 +1 berries	19.9	0.005

corrected for anthocyanin, at 440 mμ, during storage at 45° C. The half life for pigment degradation was 8.5 days. Increase in browning was practically identical in the two cases.

In another experiment, 60 lbs. of 1 + 1 Marshalls were concentrated from 58 to 71% solids in 3 minutes at 93° F. at a vacuum of 29.6 in. The temperatures of the inlet and outlet condenser water were 78 and 81° F., as before, but the jacket steam pressure was increased to 15 p.s.i.g. Half of the batch was packed cold and the other half was pasteurized to 185° F. in an open kettle. The time required was 5 minutes. There was a pigment retention of 93% during concentration, and of 71.5% in the overall process. This corresponds to a 21.5% pigment loss due to the additional heat treatment. Both runs indicate that a final solids content of the gel portion should be about 75% in order that the preserve will equilibrate to 68% solids.

Pigment losses are caused by a number of factors several of which have been studied by Sondheimer and Kertesz *(6a, 6b)*, and Meschter *(5)*. The pigment half-life is markedly reduced by the presence of ascorbic acid, particularly when trace amounts of copper are available for the catalysis of the oxidation of ascorbic acid.

To test the hypothesis that an oxidative mechanism is a major factor in pigment disappearance, experiments were run with a homogenate of the pasteurized preserve into which air had been incorporated, with the original preserve as a control, and also with free run juice from frozen 4 + 1 berries. Pasteurization was effected by a rapid heating to 185° F., after which the product was cooled. The rate of pigment loss at 45° C. was between 4 and 5 times as high in the homogenate of the preserve, and 13 times as fast in the juice. This can only be interpreted as an oxidative effect, whether direct or indirect.

Non-enzymatic browning reactions are numerous and varied *(7)*. The Maillard-type reactions, exemplified by hexose-amino acid browning, are characterized by an induction period of some weeks at 70° F. *(7)*, and therefore cannot, in the early stages, be major contributors to the total observed browning. That uronic acids, ascorbic acid, other organic acids, sugars and amino acids interact need not be questioned. Thus Livingston *et al. (3)* have recently discussed discoloration in pectin gels, a reaction between sugars, acids and the pectin. Unpublished data indicate that low levels of uronic acid in the strawberry are minor contributors to browning and exhibit no catalytic effect. However, in the presence of anthocyanin at the somewhat critical level found in strawberry, an oxidative mechanism can play havoc with the color, and ascorbic acid in particular may cause severe browning.

One may consistenly observe (see below) a linear relation between pigment loss (in mg./100 g. preserve) and browning (increase in optical density at 440 mμ). The brown product arises either concomitantly with, or as a direct result of, pigment degradation. This relationship is shown in Figure 1, where pigment losses at 45° C. over a period of 4 days are plotted for numerous samples, regardless of treatment, as a function of the observed browning. This shows that the ratio of pigment to browning remains essentially constant throughout the course of pigment destruction. In strawberry juice, there is an initial increase in browning not accompanied by a pigment loss. Subsequent to this lag, which amounts to about 20% of the total browning (i.e. the total amount formed by the time most of the pigment has been destroyed), the ratio of pigment to browning becomes constant.

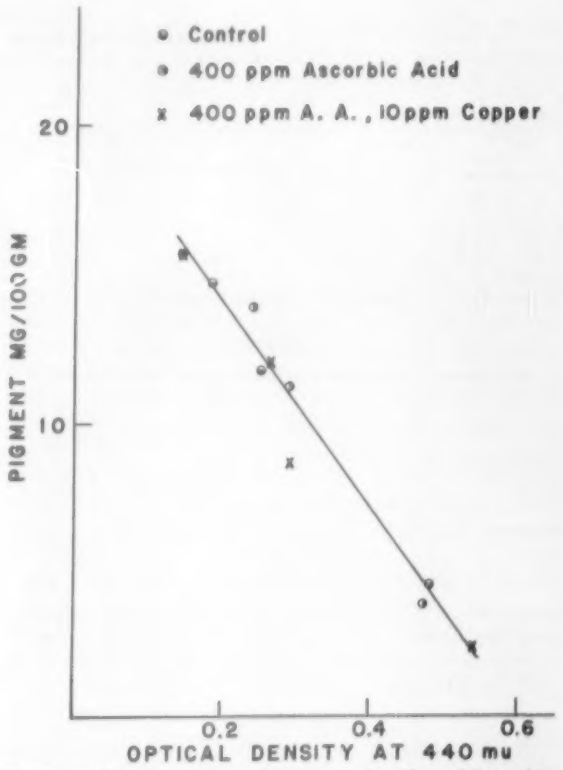

Figure 1. Showing pigment losses as a function of browning.

The experimental evidence is as follows: The natural pigment, pelargonidin 3-glucoside (300 mg.) was first prepared by the method of Sondheimer and Kertesz *(6b)*; a series of solutions containing 4.75 mg. pigment per 100 ml. of 0.1 M citrate buffer at pH 3.4 were prepared, to which various amounts of glycine, sugars and ascorbic acid were added (Table 2). Thymol was used as a preservative. These were heated for 8 days at 45° C.

In all cases, except one, the pigment loss can be related to a browning increase, within the limits of the experimental error. (In sample No. 3 there was in addition a reaction between glycine and ascorbic acid, resulting in increased production of brown artifacts.) Thus, one may relate the pigment loss directly to browning increase, and this is independent of the rate at which the conversion occurs. Of the compounds studied, ascorbic acid and fructose were most active in catalyzing the pigment breakdown, particularly in the presence of glycine.

Further evidence (Table 3) was obtained by comparing the rate of browning of strawberry juice with that which had been butanol-extracted. The pigment of a juice containing 30% solids was extracted with butanol which had previously been equilibrated with a 0.1 M citrate buffer solution at pH 3.4. The samples were stored at 75° C. At the end of 6 hours there was a noticeable percentage increase in browning in both cases. However, the browning of the butanol-extracted sample was only 14.5% of that of the non-extracted juice.

Again, these data indicate that a large percentage of browning formation is a direct result of pigment conversion which is accelerated by subjecting the strawberries to high temperature treatment even for short periods of time. The pathway of pigment degradation does not appear to involve the hydrolysis to the aglucone, for the following reason: during the continuous

TABLE 2

Factors affecting changes in solutions of pure pigment

	Pigment mg./100 g.	Pigment loss mg./100 g.	Browning (observed) Optical density at 440 mμ	Browning[1] (calculated)	Difference Browning (calculated-observed)
1. Control	2.08	2.67	0.100	0.100	0
2. 1% glycine	2.09	2.66	0.086	0.100	0.014
3. 1% glycine + 250 p.p.m. ascorbic acid	0.03	4.72	0.251	0.178	—0.073
4. 1% glycine + 50% sucrose	1.50	3.25	0.107	0.122	0.015
5. 1% glycine + 25% fructose + 25% glucose	0.37	4.38	0.151	0.166	0.015
6. 250 p.p.m. ascorbic acid	0.22	4.53	0.160	0.172	0.012
7. 50% sucrose	2.50	2.25	0.070	0.085	0.015
8. 25% fructose + 25% glucose	1.20	3.55	0.154	0.134	—0.020
9. Control (not heated)	4.75	0.00	0.00	0.00	----

[1] On the basis of browning and pigment relationship in control *(1)*, that 2.67 mg./100 g. pigment loss is equivalent to a browning increase of 0.100.

TABLE 3

Browning of strawberry juice extracted with butanol

Sample	Time of heating (hours)	Pigment mg./100 g.	Browning optical density at 440 mμ
Butanol extracted	0	0.71	0.0302
	2	0.43	0.0406
	6	0.53	0.164
Not Butanol extracted	0	8.05	0.365
	2	7.4	0.571
	6	3.14	1.134

extraction of the juice at 60° C. with ethyl acetate, no anthocyanidin partitioned into the ethyl acetate. The foregoing evidence gives considerable support to the hypothesis of an oxidative mechanism in explaining pigment loss.

DISCUSSION

In view of the accelerating effects of oxidative conditions on both the pigment loss and browning increase and possibly on the breakdown of pigment to brown artifacts, their control is of utmost importance. It can be anticipated that any stage in processing which results in an introduction of oxygen, particularly when the product is heated, will cause a marked loss in pigment and a corresponding increase in browning.

Correct vacuum pan operation tends to limit both oxidative and non-oxidative breakdown and the greatest losses occur during subsequent operations when additional heat is applied as, for example, during pasteurization of the headspace. Recognition of the detrimental effect of heat has led Handwerk and Brown *(1)* for jellies and marmalades and Hoover, Nelson and Steinberg *(2)* for fruit jellies to suggest processing methods which minimize heat damage. The problem with preserves, where the fruit structure must be maintained, is somewhat more complex but is susceptible to solution by a similar approach, as discussed in this paper.

For commercial production, aseptic procedures would not, in themselves, be sufficient, as the original berries are not sterile. A pasteurization after, rather than before the vacuum concentration, is to be preferred as the dissolved oxygen would be at a minimum, and pigment retention would thereby be correspondingly higher.

SUMMARY

The behavior of a low temperature process strawberry preserve on storage is discussed. Prior to onset of the Maillard type of browning, caused by sugar amino acid interaction, there is linear relation between increase in browning and decrease in anthocyanin. The preserve obtained by low temperature processing may retain 90% of its original anthocyanin as contrasted with 10 to 50% by conventional procedures. To translate this to safe commercial practice, a rapid pasteurization after vacuum concentration is to be preferred, as dissolved oxygen is then at a minimum.

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The Effects of Iced and Frozen Storage Upon the Trimethylamine Content of Flounder (Parophrys vetulus) Muscle[a]

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English sole (Parophrys vetulus) were held in iced storage for periods ranging from 0 to 15 days. At intervals during this period samples were removed from the ice and filleted. Fillets were packaged, frozen, and held in frozen storage at 0° F. for periods up to 24 weeks. Samples were subjected to various spoilage tests prior to freezing and at intervals during the period of frozen storage. Of the various tests investigated, only the determination of trimethylamine was found to be of value in estimating the quality of English sole prior to freezing. The trimethylamine content of the fillets did not change during frozen storage, and it was concluded that the test could be used, after frozen storage, to indicate the quality of the flesh at the time it was frozen.

This paper reports a study of the relationship of quality prior to freezing to the changes occurring during frozen storage of fish muscle. Standard tests for spoilage were employed.

The species of fish studied was *Parophrys vetulus*—the English sole of the Pacific coast. This species is a bottom-dwelling flat fish of considerable commercial importance; annual landings in California, Oregon, and Washington total approximately 10 million pounds.

The chemical tests applied and studied included the determination of amino nitrogen content and trimethylamine content both in the flesh and in the drip of defrosted fillets, and the determination of the protein nitrogen contents of drip. Since the amino and protein nitrogen contents of the drip and the amino nitrogen content of the flesh were found valueless as criteria of quality of iced and frozen sole fillets, only data concerning the trimethylamine content are reported in this paper.

The decomposition of iced fish has been classified as bacterial, autolytic or oxidative *(6, 10)*. Recent work *(7, 9)* has shown that autolysis and oxidation are of primary importance in the spoilage of iced fatty fish, such as mackerel, whereas bacterial decomposition is the principal cause of the spoilage of iced lean fish, such as haddock. The determination of the concentration of the volatile base, trimethylamine, has been used frequently as an index of quality of lean fish muscle—the higher the trimethylamine content the poorer the quality of the fish. The precursor of this compound, trimethylamine oxide, is a non-volatile and inoffensive constituent of marine teleost flesh. The formation of trimethylamine is indicative of bacterial action, for the reduction of the oxide has been shown to be a two-stop reaction initiated by a bacterial enzyme specific for trialkylamine oxides *(15)*. The activated trialkylamine oxides are then reduced by any of the dehydrogenase systems *(14)*. However, a number of reports are available which demonstrate that there is little correlation between bacterial count and trimethylamine content of fish muscle *(13, 18, 19, 21)*. An excellent review of the literature concerning trimethylamine in fish muscle has been presented recently by Tarr *(17)*.

It is well known that changes do continue in fish while in frozen storage. The denaturation of the protein and the development of off-flavors are changes well authenticated in the literature *(1, 4, 8, 12)*. Some interest has been shown in the relationship of the post-mortem age of salmon to the development of rancidity and frozen storage *(20)*. However, the evaluation of spoilage tests before and after freezing in fish of various post-mortem ages has not been reported previously.

EXPERIMENTAL PROCEDURE

Procurement of samples. Fish used in this study were taken aboard the experimental vessel operated by the School of Fisheries, University of Washington. All fish were obtained by otter trawl. The first lot of fish was obtained in 2 hauls at the Holmes Harbor fishing grounds, November 6, 1953. The first haul was completed at 1357 hours, the second at 1444 hours. No effort was made to keep the iced fish from the 2 hauls separate and zero times was computed as 1420 hours. One group of fish was returned alive to the laboratory.

The second lot of fish was obtained from the Fletcher Bay fishing grounds, February 26, 1954. The fish were taken in 3 drags, all of which were completed between 1430 and 1530 hours. Zero time was computed as 1500 hours. Again no effort was made to keep the iced fish from the three hauls separate. One group of fish was returned alive to the laboratory.

Except for the live fish, the fish in both lots were heavily iced as soon as they were received on board. The live fish were placed in tanks of circulating sea water for transportation.

Treatment of samples. Upon arrival at the laboratory the live fish from both lots were filleted immediately. One sample (a sample consisted of 2 fillets from each of 8 fish) was analyzed as soon as possible. The remainder of the fillets were packaged in polyethylene bags (the 2 fillets of each fish in a single bag) which were then heat sealed. The packaged fillets were frozen in still air at 0° F. and held in storage at the same temperature.

The filleting operations employed for the first lot of fish were to fillet the fish and skin the fillets. Then the fillets were rinsed in cold tap water, placed on slanted No. 8 screen and allowed to drain for 30 seconds. Next, the fillets were turned over and allowed to drain again for an equal period. The fillets of each fish were then packaged individually. Groups of fish from the first lot were filleted, packaged, and frozen after 1.3, 3.2, 5.4, 8.9, 12.3, and 15.0 days' storage on ice. One sample of fish was taken at each of these times for analysis prior to freezing. Sam-

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ples from each of the above groups were removed from the freezer after 1 day, 6 weeks, 12 weeks, and 24 weeks in frozen storage. The samples were thawed in air at room temperature for 8 hours and then analyzed. All determinations were performed on each of the 8 fish that composed a sample.

A slight modification of the filleting procedure was followed with the second lot of fish. The slime was washed off the round fish with cold tap water; the fish were dried with a cotton towel. The fillets, as cut, were placed on dry paper towels and skinned. Any excess blood was wiped off and the fillets were then packaged as before in polyethylene bags. Groups of fish from the second lot were filleted, packaged, and placed in frozen storage after 0.6, 1.2, 1.8, 2.3, 2.9, 4.0, 6.0, 10.0, and 15.0 days' storage on ice. Samples were removed from frozen storage after 1 day, 2 weeks, 4 weeks, and 6 weeks. As before, a sample of fish consisted of the fillets from each of 8 fish, and the determinations were performed on each of the individuals in a sample.

The determination of drip. Drip was calculated as weight lost during thawing for 8 hours at room temperature. The fillets were thawed while in the individual polyethylene bags. After thawing, the polyethylene bags containing the fillets and the drip were first weighed, then slit, and the contents emptied into a funnel. The bags were rolled and "milked" as dry as possible. The fillets in the funnel were drained for 30 seconds, blotted with a clean paper towel, replaced in the bag, and reweighed. Loss in weight was calculated as drip. From the data the mean percentages of drip and the Standard Error of the Mean were calculated, according to the methods of Dixon and Massey *(2)*. These values are presented in Table 1.

The determination of trimethylamine. Trimethylamine content of the flesh prior to freezing, of the flesh after various periods of frozen storage, and of the drip of defrosted fillets, was determined by a modification of the colorimetric method of Dyer *(3)*. In the modification an aliquot of a sample solution containing 0.002 to 0.080 mg. of trimethylamine nitrogen was made to 4 ml. with distilled water in a test tube. One milliliter of 10% formaldyhyde, 10 ml. of moisture-free toluene, and 3 ml. of a 50% potassium carbonate solution were added. A polyethylene film was held securely over the tube and the tube shaken vigorously approximately 40 times. Six milliliters of the toluene layer were pipetted off into a second test tube and 0.3 to 0.6 g. of anhydrous sodium sulfate were added. The tube was shaken a few times to dry the toluene.

Five milliliters of the toluene solution were then pipetted into a third test tube containing 5 ml. of a 0.02% solution of picric acid in moisture-free toluene. After mixing, the optical density of the color was determined in a photoelectric colorimeter using a light source at a wave length of 420 mμ.

The standard for the color measurement was a tube of moisture-free toluene. A blank was also prepared using 4 ml. of water rather than trimethylamine solution. In this manner a reference point was established in the most sensitive region of the colorimeter scale so that extremely small amounts of trimethylamine could be determined accurately. A standard curve was prepared by the use of standard trimethylamine solutions.

The solution used in the determination of trimethylamine nitrogen in drip was the supernatant solution that resulted from the precipitation of protein in the drip by the addition of a 10% solution of trichloracetic acid. For the determination of the trimethylamine content of flesh, 2 parts of water and 2 parts of a 10% solution of trichloracetic acid by volume were added to one part by weight of fish flesh. The conglomerate was then

TABLE 1

Percentages[1] of drip of frozen English sole fillets for the indicated times on ice and in frozen storage at 0° F.

LOT NO. 1

Time in frozen storage	Days on ice						
	0	1.3	3.2	5.4	8.9	12.3	15.0
1 day	4.3	4.5	6.7	10.1	7.2	7.5	.....
S. E. M.[2]	0.5	0.3	0.2	0.6	0.4	0.4	.....
6 weeks	9.6	9.3	12.7	13.4	13.6	11.8	12.5
S. E. M.	1.0	0.5	0.5	0.7	0.7	0.7	0.5
12 weeks	8.4	8.6	11.1	11.8	11.8	.....	10.7
S. E. M.	0.8	0.3	0.6	0.6	0.5	.....	0.9
24 weeks	10.3	12.5	14.9	16.0	14.2	.....	13.2
S. E. M.	0.8	0.8	0.5	1.2	1.0	.....	0.8

LOT NO. 2

Time in frozen storage	Days on ice									
	0	0.6	1.2	1.8	2.3	2.9	4.0	6.0	10.0	15.0
1 day	4.7	3.7	5.1	5.6	4.4	5.8	6.6	6.3	8.2	7.3
S. E. M.	0.6	0.3	0.4	0.5	0.6	0.7	0.5	0.5	0.9	0.5
2 weeks	6.3	5.1	6.4	7.4	5.8	8.2	9.1	9.8	8.6	7.7
S. E. M.	1.1	0.5	0.8	0.8	0.5	0.4	0.7	0.6	0.7	0.6
4 weeks	5.4	4.8	5.4	7.0	7.2	7.2	8.9	9.3	10.0	10.0
S. E. M.	0.5	0.5	0.7	0.8	0.5	0.5	0.9	1.1	0.8	0.8
6 weeks	8.9	7.3	6.5	9.6	8.9	10.1	11.0	10.3	12.2	10.2
S. E. M.	0.7	0.8	0.9	1.1	0.7	1.0	1.1	0.8	0.9	0.2

[1] Mean percentage of drip of fillets of eight fish in each sample.
[2] S. E. M. represents the Standard Error of the Mean.

TABLE 2

Trimethylamine nitrogen content[1] (in milligrams per 100 grams of flesh) of fillets of English sole for the indicated times on ice and in frozen storage at 0° F. (Lot No. 1)

Time in frozen storage	Days on ice						
	0	1.3	3.2	5.4	8.9	12.3	15.0
0	0.44	0.46	0.71	0.77	1.73	4.68	6.50
S. E. M.[2]	0.09	0.07	0.04	0.07	0.28	0.50	1.35
1 day	0.47	0.73	0.80	1.00	1.43	4.05	6.43
S. E. M.	0.05	0.03	0.03	0.09	0.15	0.46	0.46
6 weeks	0.19	0.27	0.49	0.88	1.70	3.90	6.20
S. E. M.	0.03	0.06	0.04	0.09	0.21	0.24	0.68
12 weeks	0.77	1.14	0.95	1.15	1.26	.....	5.51
S. E. M.	0.06	0.09	0.03	0.04	0.23	.....	0.87
24 weeks	0.32	0.38	1.24	1.19	1.55	.....	6.81
S. E. M.	0.05	0.02	0.05	0.03	0.19	.....	0.94

[1] Mean of fillets of eight fish in each sample.
[2] S. E. M. represents the Standard Error of the Mean.

mixed in a Waring blender for 2½ minutes. The mixture was next centrifuged for 10 minutes at 2000 r.p.m. and the supernatant liquid used for the determinations.

The mean trimethylamine content of the flesh (in mg./100 g.) and the Standard Error of the Mean for each sample was computed. Values are presented in Table 2. Similar calculations were performed on the data from the drip of the defrosted fillets (Table 3).

Bacterial counts. Standard plate counts of fish flesh were made during iced storage prior to freezing and after 6 weeks frozen storage. Four fish were used in each of the determinations and duplicate plates were poured for each fish. The plating medium was Bacto Tryptone Glucose Extract Agar, and the plates were incubated at 30° C. for 48 hours. Mean plate counts were determined for each sample of 4 fish and Standard Errors of the Means were calculated (Table 4).

DISCUSSION

Polyethylene bags were chosen for packaging the fillets in this investigation because of the extremely low moisture-vapor transmission rate of this plastic. If appreciable amounts of moisture were lost from the surface of the fillets by sublimation during frozen storage, it would result in errors in all of the determinations. Since polyethylene is one of the most moisture-vapor proof materials commonly used for packaging frozen foods and since the bags were heat-sealed, it was inferred that any moisture lost from the surface would be kept within the bag; losses due to sublimation could therefore be ignored.

During the first part of the investigation, the question arose as to whether rinsing and draining the fillets prior to packaging and freezing might affect the drip. For this reason, these steps were omitted with the second lot. The results obtained from the 2 lots of fish were essentially the same, as illustrated by the values in Table 1, and any differences that did arise from the change of procedure were within the limits of experimental error and not noticeable.

As previously stated, a high trimethylamine content of fish flesh is indicative of bacterial action although it may not indicate the presence of a large bacterial population. The trimethylamine content of the flesh remained at a low level during storage on ice for the first 8 days. At 8.9 days the trimethylamine content began to increase sharply and continued to increase throughout the remainder of the storage time on ice. At the end of 15 days on ice, the content of trimethylamine had risen to approximately 6 mg. %. During the storage period on ice, the bacterial count first increased from 67,000 colonies per gram of flesh of fish filleted while alive, to 1,000,000 colonies per gram of flesh after 6 days iced storage. After this the bacterial count decreased to 350,000 colonies per gram of flesh at the end of 15 days storage on ice.

The decrease from one million colonies per gram to 350,000 colonies per gram is unusual and could possibly be due to sampling errors. However, it is also possible that the method of handling the fish aboard ship and in the laboratory reduced the contaminating organisms below that normally encountered in fillets obtained either from a commercial fishing vessel or a commercial filleting line. The temperature of incubation (30° C.) may have been too high for the development of colonies of the psychrophilic organisms normally present on fish, resulting in an apparent decrease in bacterial counts.

The value of 6 mg. of trimethylamine nitrogen per 100 g. of fish is much lower than most values reported in the literature for fish spoiled by bacterial action. However, Table 5 presents the organoleptic observations of the first lot of fish during the period of iced storage and demonstrates that fillets cut from English sole after 15 days' storage on ice would be unacceptable for human consumption. These findings are in agreement with those of Tarr and Ney *(19)* who noted that the amount of trimethylamine formed during spoilage of many species of fish taken from the North Pacific Ocean are usually much lower than values reported for Atlantic Ocean species. The results obtained for the trimethyla-

TABLE 3

Trimethylamine nitrogen content (in milligrams per 100 milliliters) of drip[1] of defrosted English sole fillets for the indicated times on ice and in frozen storage at 0° F.

Time in frozen storage	Days on ice								
	0	1.3	3.2	5.4	6.0	8.9	10.0	12.3	15.0
1 day	0.51[2]	.....	.....	.....	0.66[2]	.....	2.52[2]	5.47[2]	6.10[2]
S. E. M.[3]	0.08	.....	.....	.....	0.10	.....	0.49	0.74	0.85
6 weeks	0.33	0.52	1.00	1.32	.....	2.14	.....	3.32	6.97
S. E. M.	0.09	0.09	0.05	0.13	.....	0.12	.....	0.17	0.34
12 weeks	0.76	1.06	0.51	1.64	.....	0.71	.....	.....	4.05
S. E. M.	0.07	0.03	0.15	0.07	.....	0.17	.....	.....	0.73
24 weeks	0.45	0.50	2.46	2.86	.....	2.03	.....	.....	5.76
S. E. M.	0.07	0.05	0.13	0.09	.....	0.15	.....	.....	1.08

[1] Mean of fillets of eight fish in each sample.
[2] Fish from Lot No. 2. Other data in table from fish in Lot No. 1.
[3] S. E. M. represents the Standard Error of the Mean.

TABLE 4

Standard plate colony counts[1] of bacteria of fish fillets, as thousands of colonies

	Days on ice							
	0		6.0		10.0		15.0	
	Mean	S. E. M.[2]	Mean	S. E. M.	Mean	S. E. M.	Mean	S. E. M.
Prior to Freezing	67	2	1000	141	790	54	350	11
After Six Weeks' Storage at 0° F.	14	2	200	24	97	8	47	6

[1] The mean of duplicate determinations on each of four fish.
[2] S. E. M. represents the standard error of the mean.

TABLE 5

Organoleptic impressions of the first lot of fish during iced storage

Days on ice	Appearance of eyes	Appearance of gills	Odor of gills	Appearance of belly	Texture of flesh	Odor of flesh
Zero	Normal, shiny	bright red, healthy	fresh, salt-water-like	uniform	firm	little odor, salt-water-like
1.3	Very slightly glazed	red, a little slimy	fresh	uniform	very firm (in rigor)	little odor, fresh
3.2	Beginning to recede, more glazed	red, rather slimy	a little stale, a trace of trimethylamine odor	a few individuals with distended bellies	very firm (some individuals out of rigor)	little odor
5.4	Sunken	light red, slimy	definite stale odor, trimethylamine and hydrogen sulfide odor	most individuals with distended bellies	few	slightly stale, trimethylamine odor
8.9	Sunken, misshapen, glazed	brownish-red, very slimy	very strong odor, unable to identify individual odors	dished in, rectum sometimes protruding	soft, flabby, difficult to fillet	stale, ammonical odor
12.3	Sunken, misshapen, glazed	brownish, slimy	very strong	dished in, as above	slightly firmer	definitely stale, ammonical odor

mine content are of the same order as those previously reported by Tarr *(16)* working with the same species of fish.

Figure 1, a representation of the data presented in Table 2, illustrates the absence of a consistent trend or correlation of trimethylamine content of the flesh and time of frozen storage. This lack of correlation indicates that the observed variances in trimethylamine content for a particular time of storage on ice are random and most probably due to experimental errors.

When the data are presented in a more conventional manner, Figure 2, a definite and consistent trend of increased trimethylamine content with increased time on ice is clearly demonstrated for each of the periods of frozen storage. Differences that exist between the curves for the various periods of frozen storage appear small and, again, the inconsistencies between the differences may be noted. In the majority of cases, differences between means for a particular time of storage on ice are not significant. Therefore, the results indicate that the trimethylamine content of fillets of English sole depend upon the length of time of storage of the fish on ice and is not affected by subsequent freezing and storage at 0° F. for periods up to 24 weeks.

The bacterial population, as measured by standard plate colony counts of the defrosted fillets, decreased

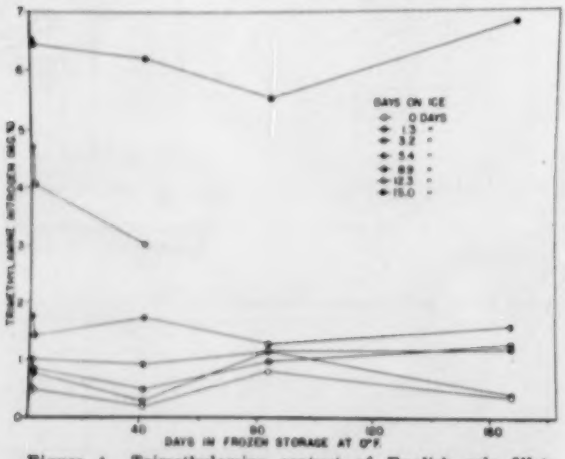

Figure 1. Trimethylamine content of English sole fillets (trimethylamine content versus time of frozen storage).

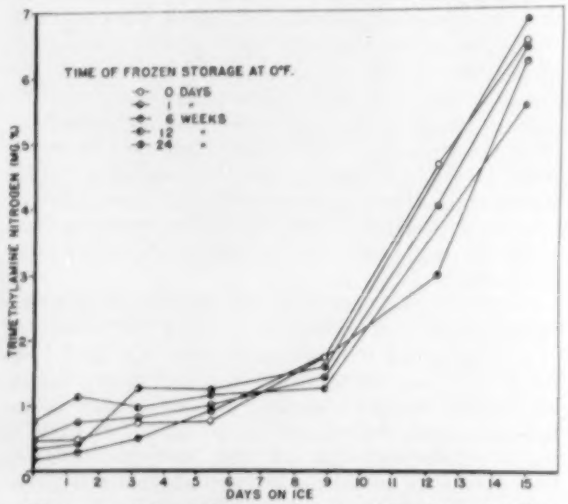

Figure 2. Trimethylamine content of English sole fillets (trimethylamine content versus time of iced storage).

during the period of frozen storage. There was an average decrease of 86% after 6 weeks at 0° F. Since the trimethylamine content of the fillets did not change significantly during the freezing, frozen storage, and thawing operations, while the bacterial counts decreased sharply, it would appear that very little of the trimethylamine content of the flesh was formed during the defrosting operations. The 86% decrease in bacterial content during frozen storage at 0° F. is in agreement with results recently reported by Shewan *(11)* and previously by Gibbons *(5)*.

The trimethylamine content of drip for all periods of storage at 0° F. followed the same pattern as in the flesh and increased to approximately the same value. Therefore, similar conclusions can be drawn from the results of the trimethylamine determinations on drip as from the results of these determinations on the flesh. However, conclusions drawn from the results of the application of the test to drip are less certain than in the case of the flesh due to greater variations in the trimethylamine content as exhibited by the values of the Standard Error of the Means (Table 3). The increased variations in the trimethylamine content of the drip as compared

to the flesh lends support to the surface concept of spoilage advanced by Wood, Sigurdsson and Dyer *(22)*. If this concept is correct, the drip, which in these samples was held in direct contact with the surface of the fillets during thawing, would be a more sensitive indicator of small variations in the trimethylamine content than the determinations performed in the flesh. On the other hand, the variations might be an indication of the bacterial action during the defrosting operation. Regardless, the trimethylamine content of the flesh would give a more representative measure of the condition or quality of the fillet.

The opinion has been expressed generally that trimethylamine determinations are of little value in estimating the quality of frozen fish. Experimental evidence presented in this paper indicates, however, that the trimethylamine values obtained from English sole fillets stored at 0° F. are correlated directly with the condition of the fillets at the time of freezing and may be used as a measure of their quality at that time. If consideration is given to the bactericidal action of freezing and frozen storage and also to the decreased enzymatic activity in the solid state and at low temperatures, then little if any increase in the trimethylamine content of frozen fish is expected. On the other hand, if consideration is given to the relatively high boiling point of trimethylamine (38.3° F.) when compared to freezing temperatures, then little loss of the trimethylamine content would be expected due to volatilization, and the only loss would be that due to sublimation. A conclusion may therefore be drawn that the trimethylamine content of fish muscle will remain constant during freezing and frozen storage at temperatures commonly used in commercial freezers. This conclusion is verified by the experimental evidence presented above.

Although the trimethylamine nitrogen determinations present evidence for the evaluation of the quality of fish flesh prior to freezing, they are of no value in estimating the amount of deterioration that occurs during frozen storage.

SUMMARY

English sole *(Parophrys vetulus)* were obtained from the waters of Puget Sound by otter-trawl. The fish were held in ice for periods up to 15 days. At intervals, during the iced storage period, groups of fish were removed and filleted. Trimethylamine determinations were run on samples from each group. The remainder of the fillets in each group were packaged in polyethylene bags which were then heat sealed and placed in frozen storage at 0° F. At various periods, between one day and 24 weeks of frozen storage, samples of each group of fish were withdrawn and determinations of quantity of drip, trimethylamine content of drip, and trimethylamine content of flesh were performed. In order to obtain data for a storage period of 0 days on ice, fillets were removed from live fish.

Bacterial counts were performed at intervals during the period of iced storage and after 6 weeks' frozen storage. The colony counts increased from 67,000 per gram of flesh filleted from live fish, to a maximum of 1,000,000 per gram of flesh after 6 days' storage, and then decreased to 350,000 per gram of flesh after 15 days' storage on ice. These counts decreased by an average of 86% after freezing and storage for 6 weeks at 0° F.

The trimethylamine content of the flesh remained at a low level until 8.9 days, after which the content increased sharply attaining a value of approximately six milligrams per 100 g. of flesh at the end of 15 days. At this time the fish was considered inedible. An analysis of the data demonstrated that the trimethylamine content of the fillets did not change while in frozen storage. Therefore, it was concluded that the trimethylamine content of frozen English sole fillets may be used as an index of the quality of the fish prior to freezing.

The trimethylamine content of the drip of defrosted fillets was shown to follow the same pattern as exhibited by the fillets, although the variation between individual samples was greater than in the flesh. The possible reasons for the increased variations in the trimethylamine content of the drip were discussed briefly.

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Effect of Freezing Ground Pork and Subsequent Storing Above 32° F. Upon the Bacterial Flora[a]

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The survival of added food poisoning micrococci and indigenous Gram-negative-rod type bacteria (mainly psychrophilic) in unseasoned frozen, ground pork at 0° F. to —8° F. was studied. Secondly, but no less important was an observation of the multiplication of these bacteria when samples of meat were removed from the freezer and held at temperatures above 32° F. for varying intervals of time.

Preservation of meat by freezing, both in the home and commercially, has become a large enterprise. There are approximately 500 freezer-locker plants and more than 100,000 home freezer-storage units in Kansas.

A low number of microorganisms should be one of the primary objectives in processing meats and other foods for freezing, and also in handling these products after removal from frozen storage. It is not only desirable to prevent high counts of bacteria which affect quality adversely but also to prevent contamination with pathogens. The most common type of "food poisoning" is caused by enterotoxin produced by the excessive growth of certain strains of *Micrococcus pyogenes* var. *aureus* in foods held for varying time intervals in the "incubation zone," approximately 50° F. to 120° F. *(2)*.

One purpose of this investigation was to ascertain the approximate percentage survival of both added food poisoning micrococci and the indigenous Gram-negative-rod type bacteria in unseasoned, frozen, ground pork after varying storage periods. Another aim was to observe how rapidly the surviving bacteria could multiply when the meat was held for varying intervals of time at different temperatures after removal from storage.

Sulzbacher *(4, 5)* demonstrated that certain psychrophilic bacteria were able to multiply at temperatures of 21° F. to 25° F. He emphasized the necessity of low bacterial loads on fresh meat at the time of freezing if a low count product is to be attained on removal from the freezer. Psychrophiles multiplied more slowly in frozen and thawed meat than in unfrozen ground meat.

Proctor and Phillips *(3)* studied the survival of microorganisms in certain frozen precooked foods stored at —5° F. During the first month a sharp drop occurred in numbers of microorganisms, with a gradual decline thereafter. At the end of 5 months' storage considerable numbers of viable organisms still remained in all products.

Jensen *(2)* stated that when frozen meats were held at 24° F. there was greater destruction of vegetative bacterial cells than at —22° F., especially after 3 weeks' storage.

Hartsell *(1)*, studying the survival of certain pathogenic bacteria on the surface of frozen beef and peas, observed that *Micrococcus pyogenes* var. *aureus* was more resistant than some *Salmonella* species.

PROCEDURE

In the first experiment, January 8, 1948, an 8-pound quantity of unseasoned, ground pork (approximately 50% fat) was prepared from the trimmings of a hog carcass that had been refrigerated at 32° F. to 34° F. or 10 days after slaughter. A known food poisoning strain of *Micrococcus pyogenes* var. *aureus* was inoculated into the 8-pound mass of meat (approx. 325,000 cells per g.) by adding 40 ml. of a saline suspension of cells from a 24-hour tryptone-glucose agar slant, dropwise while mixing by hand. This was followed immediately by two passages through a hand meat grinder to facilitate distribution of the added micrococci as uniformly as possible throughout the meat. The pork was then apportioned into 150 to 200-g. samples, wrapped first in laminated foil and then in brown paper, and sharp frozen in a blast of cold air at —10° F. A period of only 2 hours elapsed between removal of the meat from the refrigerator and placing the wrapped samples into the sharp freezer.

Bacteriological analyses were performed periodically on the ground pork over a span of 18 months. A 1-in-10 concentration was first prepared by adding 50 g. of meat to 450 ml. of sterile

[a] Contribution No. 304, Department of Bacteriology, Kansas Agricultural Experiment Station, Manhattan.

distilled water in a sterile quart mason jar and thoroughly mixing for 5 minutes by means of a blender (osterizer). From this 1-in-10 concentration appropriate dilutions were plated. *Micrococcus pyogenes* var. *aureus* counts were made on Chapman's mannitol-salt agar and the Gram-negative flora were determined on tryptone-glucose agar.

Additional 50-g. samples of the ground pork in Experiment 1 were sliced from the 150 to 200-g. portions when they were removed from the freezer for bacteriological analyses. These 50-g. samples were forthwith stored at different temperatures above 32° F. for varying intervals of time and then plated for *Micrococcus pyogenes* var. *aureus* and the Gram-negative-rod types, to observe the rate of increase, if any, of the two types of organisms at the various storage temperatures.

In Experiment 2 (March, 1948), a fresh pork shoulder, age unknown, was purchased at a local meat market. The meat was removed immediately from the bones and ground. Eight pounds of this unseasoned pork with a fat content of approximately 30% was inoculated with the same micrococcus (approximately 425,000 cells per g.) and handled in exactly the same manner as the meat in Experiment 1.

In Experiments 1 and 2 the food poisoning micrococcus count was made by incubating the plates at approximately 98° F. for 48 hours. This temperature inhibits the growth of psychrophilic Gram-negative-rod type bacteria which commonly cause deterioration of meat at low temperatures. The 7% NaCl in Chapman's agar acted as an inhibiting agent toward organisms other than micrococci. The Gram-negative-rod type flora were determined by incubating plates at 55° F. and 70° F. for 4 days to ascertain numbers of psychrophiles and mesophiles. Since micrococcus colonies appeared at 70° F. and not at 55° F., the number of micrococci per g. at 98° F. was subtracted from the total count at 70° F. There was so little difference between the Gram-negative-rod counts at 55° F. and 70° F. that the 2 counts were averaged and reported as one.

RESULTS AND DISCUSSION

Experiment 1. Samples of ground pork removed weekly from frozen storage and analyzed bacteriologically showed a rapid decline from the initial 325,000 *Micrococcus pyogenes* var. *aureus* per g. of meat to between 125,000 and 140,000 per g. during the first 4 weeks. During the next 6 months numbers of food poisoning micrococci decreased gradually, to approximately 50,000 per g.

Samples plated over the last 10 to 11 months of the storage period revealed that the numbers of *Micrococcus pyogenes* var. *aureus* remained almost constant, and at the end of 18 months approximated 40,000 cells per g. (Figure 1).

The naturally occurring Gram-negative-rod type bacteria in the meat dropped rapidly during the first month from 1.4 million to approximately 400,000 per g. Thereafter the decrease was gradual, and at end of the 6th and 18th months, plate counts were 100,000 and 5,000 per gram of ground pork, respectively (Figure 2).

The ground pork in Experiment 1 showed few or no colonies other than micrococci appearing on plates of tryptone-glucose agar (without salt) at 98° F. This demonstrates the psychrophilic nature of the Gram-negative-rod type flora. The predominant organism was tentatively identified as *Alcaligenes metalcaligenes;* it produced no visible growth on an agar slant at 98° F. in 48 hours, but grew luxuriantly at 70° F.

When three 1- to 3-week-old 50-gram samples of frozen meat were placed at 37° F. to 52° F. for as long as 72 hours there was little or no increase in numbers

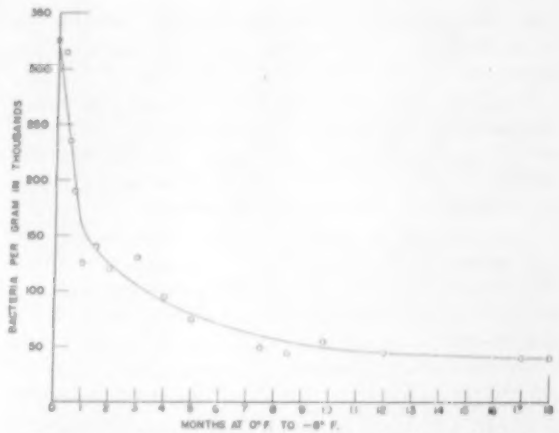

Figure 1. Longevity of a food poisoning micrococcus (Micrococcus aureus) in frozen, unseasoned ground pork trimmings—approximately 50% fat.

of *Micrococcus pyogenes* var. *aureus.* A similar sample of meat removed from the freezer after 3 weeks and held at 48° F. to 52° F. for 72 hours revealed an increase in the Gram-negative-rod flora from less than 1 million to approximately 2 billion cells per g.

A sample of ground pork, which had been frozen 2 weeks and placed at 60° F. to 65° F. for 21 hours, showed an increase in the food poisoning micrococci from less than 325,000 to 750,000 per g., while the Gram-negative-rod types increased from less than 1 million to 33 million per g.

A 6-week-old sample of frozen meat placed at 68° F. to 72° F. for 25 hours had a Gram-negative-rod count of 200 million and a *Micrococcus pyogenes* var. *aureus* count of 2.4 million per g.

When a sample of meat was removed from the freezer and held 25 hours at 80° F. to 85° F., food poisoning micrococci increased to 40 million per g. and the corresponding Gram-negative-rod count was 1.3 billion. On the contrary, when a similarly handled sample was stored only 6 hours at the same temperature range there

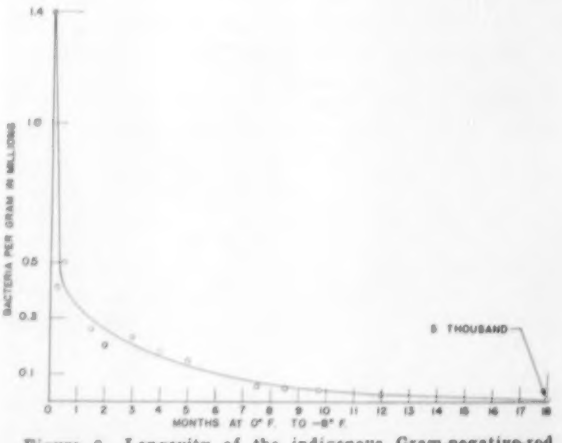

Figure 2. Longevity of the indigenous Gram-negative-rod flora (mainly psychrophiles) in frozen, unseasoned ground pork trimmings—approximately 50% fat.

was practically no increase in micrococci, whereas the Gram-negative-rod forms had increased slightly, from approximately 425,000 to 1.3 million per g.

The indigenous micrococci in the ground pork before inoculation, in Experiment 1, amounted to 11,000 per g. on Chapman's mannitol-salt agar. No further consideration was given these naturally occurring micrococci during the course of the experiment.

The decrease in numbers of *Micrococcus pyogenes* var. *aureus* in the ground pork in Experiment 2 was not so rapid during the first month as was the decline in numbers of micrococci for the corresponding period in Experiment 1.

At the end of 5 months (Experiment 2) there remained approximately 75,000 viable food poisoning micrococci and 25,000 Gram-negative-rod type bacteria per g. of meat.

It should be remembered, when considering bacterial counts on meat samples removed from the freezer and placed at higher temperatures for varying intervals, that a considerable period of time is necessary for the interior of the portion of meat to reach the temperature of its environment. Actually, the bacteria throughout the meat were not exposed to the more favorable growth temperatures for so long a time as indicated.

SUMMARY

A food poisooning strain of *Micrococcus pyogenes* var. *aureus*, when inoculated into fresh, unseasoned, ground pork (50% fat)—Experiment 1—at the rate of approximately 325,000 cells per gram, dropped to less than 150,000 per gram in one month at 0° F. to —8° F., and thereafter numbers decreased gradually to about 50,000 per gram in 10 months. At 18 months approximately 40,000 food poisoning micrococci per gram still remained in the frozen meat.

When a second lot of unseasoned ground pork (30% fat)—Experiment 2—was inoculated with the same food poisoning micrococcus, decline in numbers was more gradual, falling from 425,000 to approximately 335,000 per gram in one month at 0° F. to —8° F. At the end of 5 months there were 75,000 viable cells of *Micrococcus pyogenes* var. *aureus* per gram of meat.

The natural flora of the ground meat in Experiment 1 was comprised essentially of psychrophilic, Gram-negative-rod types (carcass stored 10 days at 34° F. before cutting). These non-pathogenic bacteria, which cause deterioration of meat at low temperatures, declined from 1.4 million to less than 0.6 million per gram in 1 week at 0° F. to —8° F. After 1 week, the decrease in numbers of psychrophiles was gradual and 150,000 per gram were present at 5 months, 40,000 at 10 months, but only 5,000 per gram were present at the end of 18 months. Food poisoning micrococci therefore die at a slower rate than psychrophilic, Gram-negative-rod bacteria in frozen, unseasoned, ground pork.

When portions of meat in Experiment 1 were removed from the freezer and stored as 50-gram samples at temperatures of 48° F. to 52° F. for up to 3 days, there was no discernible multiplication of *Micrococcus pyrogenes* var. *aureus*, whereas the psychrophiles increased to approximately 2 billion per gram. A similar sample placed at 68° F. to 72° F. and held 25 hours contained 2.4 million food poisoning micrococci and 200 million psychrophiles per gram. A comparable sample of meat at 80° F. to 85° F. for 25 hours showed 40 million micrococci and 1,300 million psychrophiles per gram.

It is not known whether a food poisoning micrococcus count of 40 million per gram (the highest obtained in this study) would be adequate to produce sufficient enterotoxin to cause symptoms of "staphylococcus" gastroenteritis. However, the numbers of *Micrococcus pyogenes* var. *aureus* per gram in the more quickly thawed surface areas of the meat may have been significantly greater than 40 million, with the possibility of a much higher concentration of enterotoxin.

Acknowledgment

The author acknowledges the assistance of Prof. D. L. Mackintosh, Department of Animal Husbandry, Kansas State College.

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Role of the Evaporator in the Production of Frozen Concentrates

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(Manuscript received July 13, 1954)

Design of evaporator units for the production of frozen concentrated juices has progressed significantly since the early units of 1945. The evaporator must now be considered in relation to the complete process. The tremendous strides made in the control of other processing variables have had a bearing on evaporator design. Important factors in evaporator design are heat transfer rates, vapor velocities, control of sanitation problems, removal of noncondensables, and the general problem of transit times in relation to storage volumes. The economies to be gained or lost through interstage cooling or reheating are discussed. An example of the design of a multistage double effect unit fitted to a particular plant and a particular process is given. The problem of evaporator design is also discussed in relation to the most economical unit for the production of a particular kind of product. Improved production techniques have removed the stimulus for improvement of certain evaporator features. At the present time, unless the processor asks for different features, evaporator improvement will be principally directed at economies in manufacture and operation.

Much has been published on low temperature evaporators, particularly those designed for the production of citrus concentrates *(1, 3, 4, 6, 8, 12, 13)*. The most common type in use today is the falling film unit. This paper will be confined to problems surrounding the design and use of such equipment. In the early stages of development great stress was placed on operating temperatures, on through-put rates, and minimum storage in the evaporator bodies. As the industry grew many important techniques relating to general plant operation have been developed. These developments, together with the increasing competitive situation, have altered radically the role the evaporator plays in the production of frozen concentrates.

Today, in a well-managed plant, the juice fed to the evaporator is reasonably free from significant mold and bacterial contamination. The physical and chemical components (such as pulp level and enzyme activity) are controlled. Prior to packaging, aroma and taste are rebalanced by techniques such as blending for ratio (sugar/acid), fresh juice addition and essence addition. The plant operators have, therefore, come to depend on the evaporator primarily as a water removal device which should not have a deleterious effect on final product, but which is not expected to add anything in the way of improved flavor or aroma.

DETAILS OF DESIGN

Falling film evaporators are generally designed to transfer heat from the production of vapor and not for the purpose of sensible heating. In addition, in the production of foods, the aim has been to avoid temperature differentials caused by excessive pressure drops. This means that the tube (or vapor passage) must be large enough to pass the vapor generated without developing high vapor speeds. However, as tube size (diameter) increases the circulating rate to keep the lateral area wet must be raised. Although these would seem to be elementary statements, their importance is by no means universally understood or accepted, particularly in the concentrates industry. Constant efforts are being made to reduce tube size and circulating rates. While investment and process savings are worthy goals, the results of poor design are never satisfactory.

The interrelation of these factors is shown in Figures 1 and 2. Experience has shown that at a vapor velocity within a tube of about 300 feet/second pressure drop is not objectionable. Figure 1 shows the number of 3-inch 16-gage tubes required to maintain a 300 foot/second velocity at various evaporation rates and temperatures.

With this taken as the base, Figure 2 shows a correction based on tube diameter; the correction factor indicates the number of tubes of a diameter less than 3 inches required to maintain the above mentioned velocity of 300 feet per second. The correction factor can also be used to determine vapor velocity itself in that if 100 tubes 3 inch in diameter are indicated for 300 feet per second, and 1½ inch tubes are desired to be substituted for

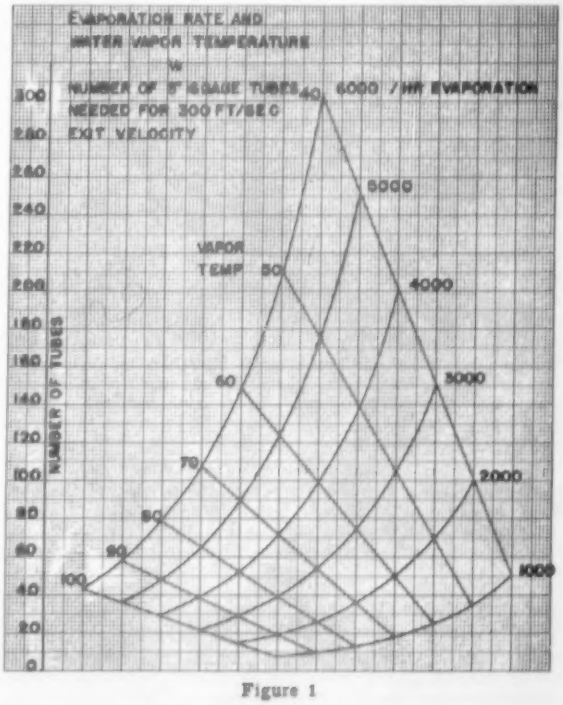

Figure 1

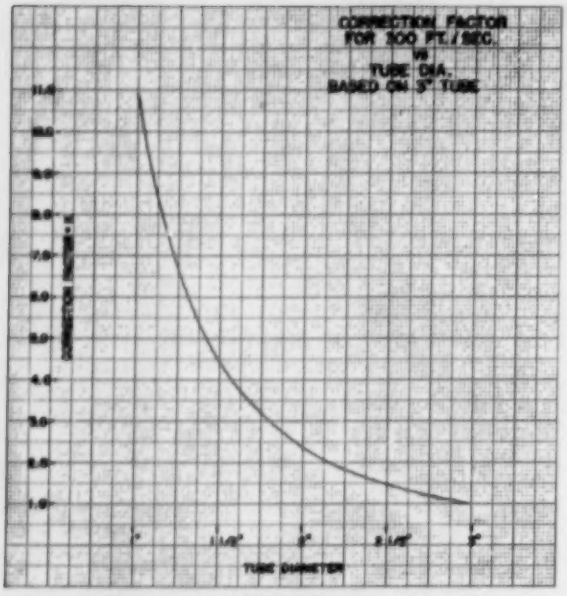

Figure 2

the 3-inch tubes, then the velocity in the 1½ inch tubes will be four and one-half times the 300 feet per second, or 1350 feet per second.

Velocities in this range result in excessive pressure drop which in turn produces sensible heating within the tube. This condition is undesirable not only because temperatures may exceed specified limits but also because it decreases the mean temperature difference. As an example, many units are designed with mean temperature differences of about 11° F. between condensing vapor to boiling liquid. If excessive pressure drop causes an increase of 2° F. in the liquid film temperature, an average loss of 1° F. occurs in the mean temperature difference. In this case it represents a 9% loss in heat flux—or, as an analogy, is equivalent to losing 9% of the heat transfer surface.

The above phenomenon should not be confused with the elevation of boiling point caused by the concentration of the natural solids existing in most juices. Normally the boiling point elevations for sucrose solutions are used in designing fruit juice evaporators.

Tressler and Joslyn *(12)* give overall heat transfer coefficients for commercial orange juice concentrators. Variation for thermal conductivity and specific heat is again solved by using values for sucrose solutions. Tressler and Joslyn *(12)* also show the effect of viscosity on heat transfer coefficients for orange juice. Florida juices exhibit as much as five-fold changes in viscosity at the same concentration for different seasonal varieties.

Heat transfer coefficients will also vary to a great extent with the amount of loading expressed as BTUs/HR per square foot of surface. Actually, a heat transfer coefficient curve will generally—when plotted against overall coefficient vs. loading—result in an inverted parabola which indicates that there is a maximum loading available, but after reaching this point the actual observed heat transfer coefficient will fall off. This is caused by vapor binding on the evaporation side of the heat transfer surface due to the loading being too great and the attempt to transfer too much heat through a square foot of surface.

Figure 3 shows this condition by plotting loading as related to condensing film temperature difference (Delta T). The higher the condensing film Delta T, the higher the loading. Thus with high loadings a typical film coefficient will decrease on the evaporating side because of the increase in loading causing vapor binding of the heat transfer surface. Thus the curve will be represented as the inverted parabola.

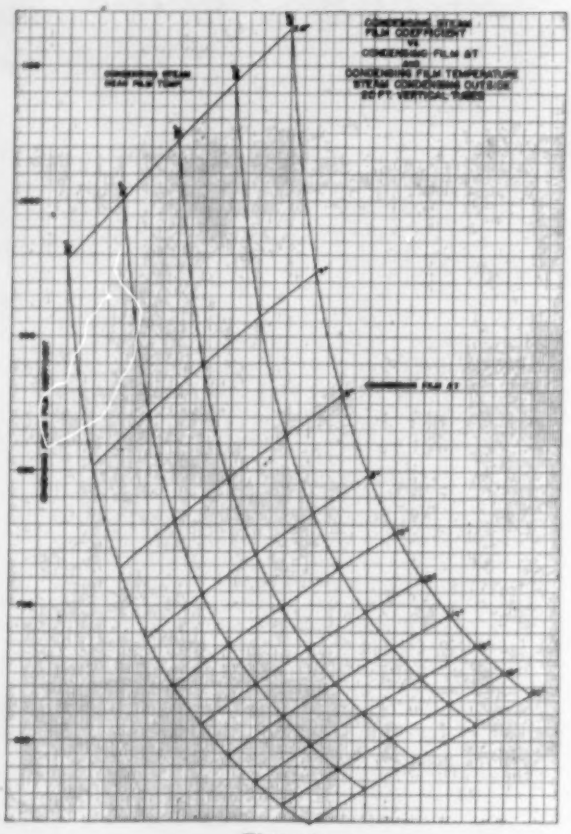

Figure 3

Another important consideration to be given to the ultimate design of any concentrator is the influence of noncondensables. Figure 4 in general shows what the presence of noncondensables can do to steam condensing coefficients—thus the general problem of venting noncondensables from the vapor side of the system is of utmost importance. Usual practice has been to purchase air pumping systems which are approximately balanced with design needs. Such practice prevents use of a controlled rate of leak operation since this procedure would overburden the pumping system. The pumping system runs at the lowest pressure desired in the system and the portions (such as the

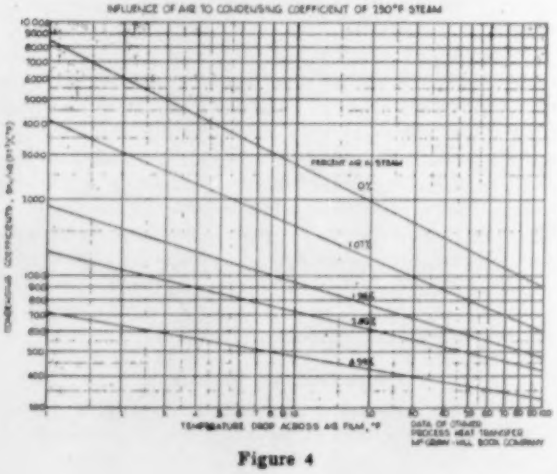

Figure 4

jackets of the second effects) operating at higher pressures are vented directly to the pumping systems.

Naturally, if the purging equipment is insufficient in capacity, the desired low pressures will not be reached. However, if purging equipment is selected for a greater capacity design conditions may be maintained with an excess amount of leakage of air into the system. Reference to Figure 4 shows that if too large a pumping system is installed the possibility of excess air exists which will decrease coefficients. Even though the temperatures and pressures appear correct the unit may not operate at design capacity.

A generally accepted and proven practice of selecting purging equipment is shown in Figure 5 where air leakage into the

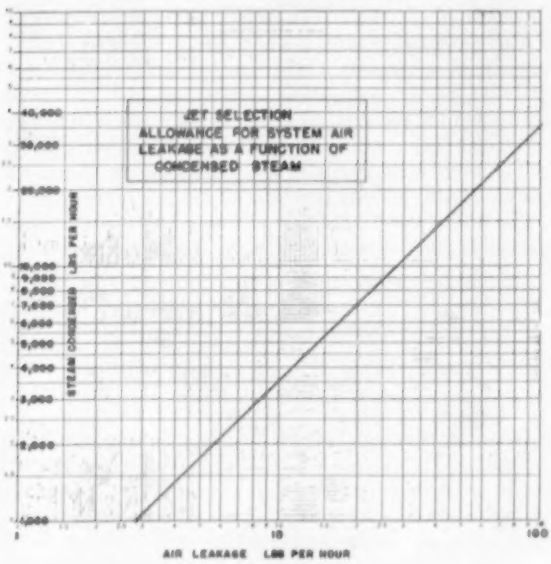
JET SELECTION
ALLOWANCE FOR SYSTEM AIR LEAKAGE AS A FUNCTION OF CONDENSED STEAM
STEAM CONDENSED LBS PER HOUR
AIR LEAKAGE LBS PER HOUR
10
100

Figure 5

system is expressed as a function of vapor condensed. Of course, the noncondensables that are brought in with the product itself in the form of CO_2, or other noncondensable gases, must be added to the air leakage.

It is important when specifying pumping systems to the manufacturers of such equipment that saturation components also be included because fundamentally these pumping systems are rated to pump so many CFM expressed as pounds per hour, and the manufacturer of the pumping system must know the total pounds per hour represented as noncondensables plus their saturation components.

Too many undissolved solids (such as pulp) in the material being concentrated can affect the operation by plugging the distribution system. They will also offer a certain resistance to the passage of heat because they materially affect bulk viscosities, and an increase in viscosity decreases transfer coefficients.

Another serious effect of high viscosities is the attendant decrease in circulating pump capacity. This can lead to poor circulation with the formation of stagnant areas, "candy" and "jelly."

The above points are complementary to mechanical considerations that must also be given to the design. Vapor lanes, means of distributing vapor into the tube bank, pressure drop evaluations, noncondensable collection areas, and other points must be considered. In the case of condensation on a vertical tube the condensate film should be interrupted so that its increasing thickness does not offer too great a resistance to heat transfer. Tube banks which are heated with a warm fluid rather than a vapor should be given detailed consideration to baffling to assure proper mass velocities for the highest heat transfer coefficient at the lowest pressure drop.

Selection of the number of stages should also be evaluated because of the change in physical and chemical properties during concentration and their adverse effect on the heat transfer coefficient.

SANITATION

As has been said, in most plants juice reasonably free of bacterial contamination is delivered to the evaporators. However, even under the best conditions it is not unusual (unless pasteurizing techniques are used) to find bacterial counts of 10,000 to 20,000 organisms per ml. in the juice in the storage tanks feeding the evaporators. These bacterial populations are sufficient to cause serious difficulties during a normal 72-hour run unless the equipment is properly designed and unless proper sanitation methods are applied. Although all properly designed equipment has a minimum of pockets and stagnant areas, there is almost always some bacterial build-up in the product in the evaporators. The amount of this build-up will depend on the particular design of the equipment and also on the manner in which it is operated. Greatest difficulties occur in areas which are intermittently or accidentally washed after periods of stagnation. Such areas are the underside of the top heads and the lower steam chest extensions, the tops and walls of the separator chambers, and the tubes themselves in cases where insufficient circulating rates are used.

Even though there was no evidence of off-flavor or other abnormalities in the product, material plated from such stagnant areas has shown counts as high as 28,000,000 *(10)* organisms per gram. If for any reason such material is washed back into the main circulating streams it "seeds" these streams and results in excessively high counts. Although there is no direct correlation of total counts with flavor *(2)*, Murdock has shown *(11)* a possible sequence by which serious trouble can occur. He demonstrated that bacteria of the *Lactobacillus* and *Leuconostoc* genera, which can produce off flavors in orange concentrate, could be introduced into the juice from split fruit. In the absence of juice pasteurization this contaminated juice feeds to the evaporators which have been shown to provide excellent anaerobic conditions for growth. Since, under normal conditions, some split fruit will enter the juice plant from time to time, the basic premise in the design and operation of evaporators should be that a serious bacterial hazard is always present.

DuBois and Murdock have shown *(5)* that the initial rate of microbial growth in orange juice decreased with increasing concentration. This is especially important in multistage or series operated systems were there is much greater opportunity for growth to take place. Not only do lower juice concentrations in themselves provide better media for bacterial action, but the juice is at such lower concentrations for longer periods of time. In addition, the greater number of evaporator bodies in the system presents more possibilities for stagnant areas. Experience indicates that in concentrating orange juice to a range between 20% to 30% solids, one evaporator body may allow a 50% increase in bacterial population, two will allow an 80% increase, while three will allow a 90% increase *(9)*. Although these conditions would seem to militate against the use of multistage systems, the problem is not serious if good sanitation measures are practiced throughout the plant.

Since storage at the evaporating temperatures (55° F. to 78° F.) should be held to a minimum and to avoid introduction of stagnant areas, most evaporators are designed to provide short transit times and minimum storage capacity. There are certain limitations on reducing storage volume because there must be some room to allow level controls to operate and for maintenance of the prime on pumps. Of even more importance is the balance between storage in the evaporator and other parts of the plant system. If there is insufficient storage elsewhere in the plant the evaporators are forced to serve as process storage tanks. In the light of the observations made above regarding contamination it is usually wiser to provide storage in equipment specifically built for this purpose. However, the evaporator must have enough reserve to allow for intermittent upsets in the upstream or downstream operations which require shutting off the flows. Experience has shown that if proper storage facilities are available elsewhere the evaporator storage can be reduced to about 15% to 20% of the hourly output. This volume is in addition to the minimum levels needed to keep pumps primed. This storage can be concentrated in one body or dis-

tributed between the first and last. The distribution depends on the operating cycle and should be carefully worked out with the production staff.

THERMODYNAMIC ECONOMIES

In evaporation systems using a refrigeration cycle for water vapor condensation, capacity is often limited by the swept volume available for the compressor. In the standard refrigeration cycle *(6, 12)* the refrigerant is expanded from the condensing temperature and pressure to the evaporating (low side) conditions. During the expansion the refrigerant flashes, thereby cooling itself. However, the flash gas must be compressed and represents a useless load insofar as net refrigerating effect at the vapor condenser is concerned. To improve this condition a subcooler is often introduced between the high side and the low-pressure receiver. The refrigerant is passed counter-current to the water condensate. In this way the condensing capacity (for water vapor) of the system can be increased about 7%.

The analagous situation for a steam cycle evaporator is the heat balance around the barometric condenser. In these systems (surface condensers are seldom used) only the condensate from the second effect jacket is available. Although it is possible to save on water usage by introducing the condensate into the main water stream, the dollar savings are usually small. In a case of water shortage or limiting temperatures some real benefit would accrue.

Most multiple-effect units in the citrus concentrate industry employ backward feed. This means that as the product is transferred from one effect to the other, additional sensible heat is required to bring the concentrate to the next higher temperature level. It is theoretically possible to eliminate this heat requirement, using streams normally present within the system, but the expense of providing the stainless piping and heat exchange apparatus has discouraged most operators from incorporating this feature.

DESIGN OF AN EVAPORATOR TO FIT A PARTICULAR PLANT

A recent design (1953) illustrates the influence of previous work and the information published here and elsewhere *(6, 12, 13)*. The evaporator was designed to fit with an existing refrigeration system capable of condensing approximately 13,000 pounds per hour of water vapor at 54° F. saturation. Balancing the economic factors against the quality and process goals resulted in the choice of a four-stage, double-effect unit. With double-effect economy, the total evaporation would be around 26,000 pounds of water vapor per hour.

The flow sheet for the unit is shown in Figure 6. The general layout is similar to units described elsewhere

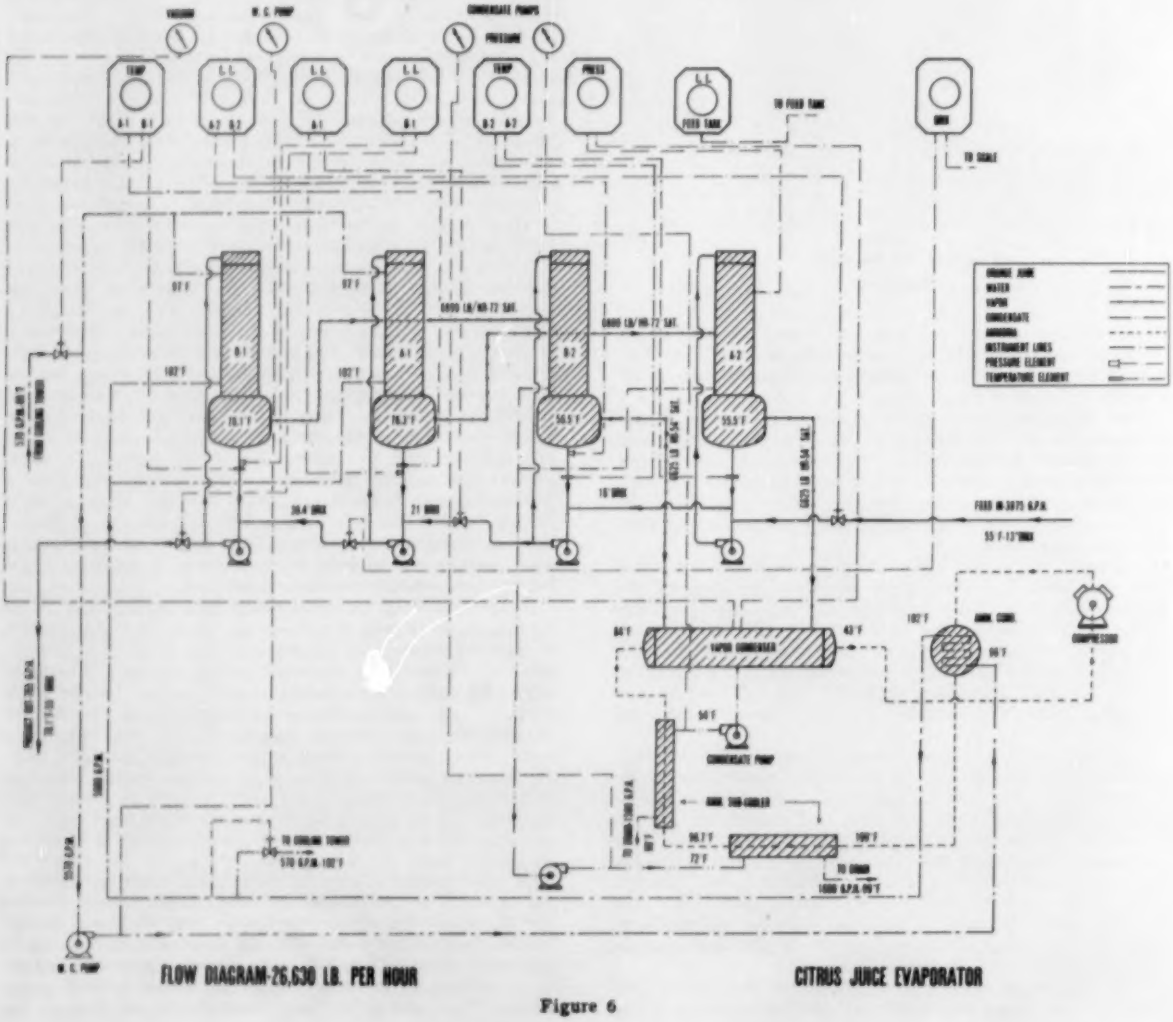

Figure 6

(6, 12). Although the bodies are piped so that there are two double-effect systems (A and B), they were not designed or intended to be operated separately. This could be done, but either system alone would have less than half the capacity of the whole unit because the Brix range and sensible heat balance would be different.

Designing the bodies for one specific condition allowed savings in first cost. The "A" system operates with 16° Brix concentrate in the second effect and 30.4° Brix concentrate in the first. This resulted in higher heat transfer coefficients than would be obtained in normal double-effect design and allowed a sizeable reduction in heat transfer area. The "B" system operates with 21° Brix concentrate in the second effect and 55° Brix concentrate in the first. These latter Brix ranges approximate normal double-effect design. The design was based on the following heat transfer coefficients:

A-2	130 BTU/Hr/Sq. Ft./° F.
B-2	115 BTU/Hr/Sq. Ft./° F.
A-1	88 BTU/Hr/Sq. Ft./° F.
B-1	70 BTU/Hr/Sq. Ft./° F.

The heat transfer areas corresponding to these coefficients were:

A-2	3,340 Square Feet
B-2	4 060 Square Feet
A-1	2,900 Square Feet
B-1	4,165 Sqare Feet

At the outset it was realized that the four-stage design presented certain hazards (previously discussed) in regard to sanitation. However, a design for three stages resulted in such extremely large bodies that the construction difficulties became burdensome. One other compromise was made by setting conditions of equal evaporation in the two second-effects and correspondingly in the two first-effects. This resulted in standardization of the separation chambers which reduced the fabrication cost. Some other arrangement might have given better sanitation control but at the present time available information could not predict this.

The unit is completely instrumented so that levels can be controlled within narrow limits. The plant in which the unit is installed had adequate storage capacity, both upstream and downstream, so that storage in the unit itself was reduced to a minimum. A double pipe ammonia subcooler was incorporated in the design to take advantage of the refrigeration saving discussed earlier.

Figure 7 is a picture of the unit and shows the remarkably clean and compact arrangement which can be obtained with this design. The "A" system faces the camera with the "B" system immediately behind it. The vapor condenser is on the extreme left.

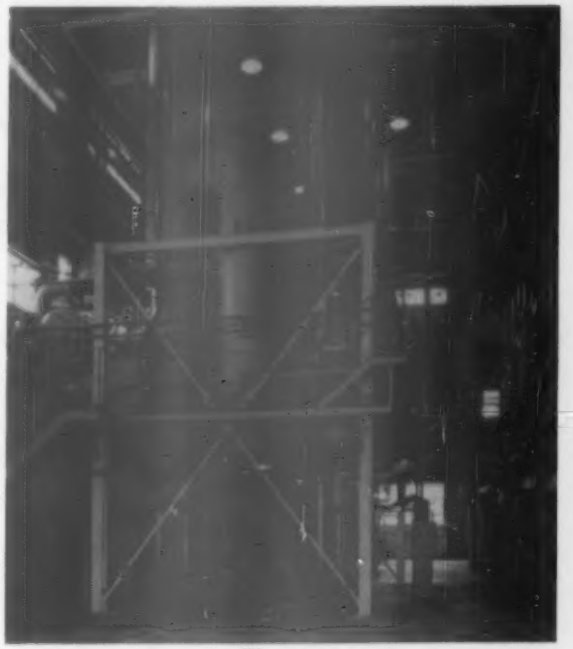

Figure 7

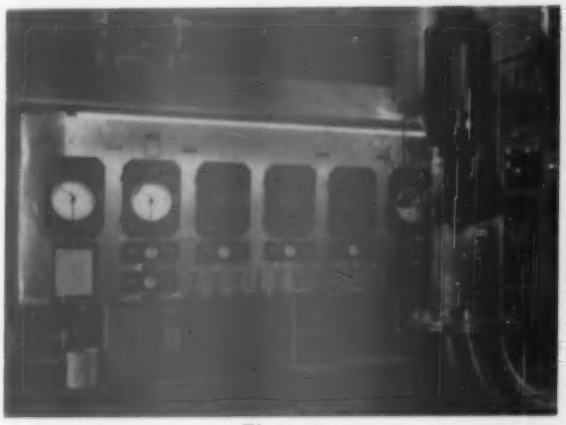

Figure 8

CONCLUSION

Two general conclusions have been reached regarding the design of evaporators. The first is: The evaporator is an integral part of the process as a whole and must be designed to fit the conditions existing in the plant. The second is: Present designs are based on the best data available but do not have as their primary goal a contribution to improved flavor. This is a reflection of the state of the art and the demands of the processors. Any improvement in this situation will have to come from the processors in the form of higher standards and a willingness to pay for the extra costs which these improvements may require.

Acknowledgment

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The Use of Monosodium Glutamate[a] in Frozen Pork Sausage[b]

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(Manuscript received February 13, 1955)

The effect of MSG on seasoned and unseasoned frozen pork sausage was studied at two levels of concentration. MSG increased the desirability of seasoned sausage after 4 months' storage. Despite some quality deterioration all groups treated with MSG were very acceptable after a year's storage.

The storage of frozen pork sausage for use from 6 months to a year later is quite prevalent among freezer locker patrons and home freezer owners. In many instances, however, the product becomes very unsatisfactory during that time. Butler *(1)* and Dubois and Tressler *(3)* show that salt in frozen sausage speeds the development of rancidity, whereas spices seem to have an opposite effect. Unseasoned ground pork, although it retains its color and original properties for a longer period in storage, is undesirable from the housewife's standpoint because of the labor involved and the difficulty of obtaining a properly seasoned product when only small amounts are thawed. Therefore, the addition of a substance to increase the freezer storage life of seasoned pork sausage is desirable.

Use of monosodium glutamate to enhance the flavor of certain foods has been widely accepted *(2, 4, 5, 8)*. Its favorable use in frozen vegetables has been reported by Shuey and Eichenberger *(7)*. Norton, Tressler and Farkas *(6)* have shown that its use in many frozen meats, including pork sausage, greatly improves the acceptability of the frozen product. These workers also stated that MSG demonstrated, organoleptically, some properties as an antioxidant.

This study was designed to test the effect of MSG on seasoned and unseasoned frozen pork sausage when added at two levels of concentration and when the sausage was kept in freezer storage for as long as a year.

[a] Supplied by Huron Milling Company, New York, N. Y.

[b] The investigation reported in this paper relates to a project of the Kentucky Agricultural Experiment Station and is published by permission of the Director.

[c] The author acknowledges the services rendered by Miss Florence Imlay, Field Agent in Foods and Nutrition, and Mrs. Pearl J. Haak, Field Agent in Foods, in preparing the sausage for the palatability tests.

EXPERIMENTAL PROCEDURE

The pork used in this study was produced from shoulders and trimmings taken from Hampshire barrows and gilts weighing about 200 pounds each. The hogs were slaughtered in the conventional manner, and their carcasses were chilled at 34-38° F. (1.1-3.3° C.) for approximately 48 hours. The meat was cut into chunks and was mixed so as to have an estimated fat content of 25-35%. In order to check the estimation, after grinding samples were obtained for moisture and ether extract determinations. Ether extraction was done by the continuous process for 6 hours, using ethyl ether. Moisture was determined by the use of a vacuum oven at 70° C. for 24 hours. Analysis revealed the mixture to contain 31.2% ether extract and 48.0% moisture.

Six groups of sausage were treated as follows:

1. Control—not seasoned.
2. Seasoned.
3. Not seasoned plus 0.1% MSG.
4. Seasoned plus 0.1% MSG.
5. Not seasoned plus 0.3% MSG.
6. Seasoned plus 0.3% MSG.

The following seasoning was added to each 6 pounds of meat:

1½ ounces salt
½ ounce black pepper
¼ ounce sage

The seasoning was thoroughly mixed with the pieces of meat before they were ground and then the mixture ground once through a 3 mm. plate. The MSG was mixed with the seasoning when seasoning was used and was mixed with the meat before grinding when seasoning was not used.

After being ground, the sausage was tightly wrapped into approximately 1 pound packages, using a heavy commercial locker paper. The weight of each package was recorded on the paper to the nearest gram. The sausage was then frozen in an air blast at 0° F. (—17.8° C.) and stored at 0° F.

After 2 months of storage, monthly taste tests were conducted. The sausage was removed from the freezer, weighed, and allowed to thaw for approximately 24 hours in a 40° F. (4.4° C.) cooler. The packages were then unwrapped and the sausage removed and placed in containers so that it could be mixed. Four pounds of sausage from each group was usually used in the taste test. Before being cooked the unseasoned sausage was seasoned at the same rate as that which had been seasoned before being frozen. All the sausage was kneaded alike in order to insure a uniform texture. The sausage was made into patties and was pan broiled in open skillets over a gas flame. The grease was poured off as it accumulated. For the first five taste tests the control group, the seasoned group containing no MSG, and the two groups containing 0.1% MSG

were used. Beginning with the sixth taste test all six groups were used.

The taste panel of 8 to 14 members included about equal numbers of men and women.

The judges ranked the samples, using a score card with the following classifications: *excellent, very good, good, fair, slightly rancid, moderately rancid, extremely rancid,* and *inedible.* The rankings were given a numerical rating of from 7 for *excellent* to 0 for *inedible.* The samples were coded in each test. The results were analyzed statistically by analysis of variance.

RESULTS AND DISCUSSION

The loss of weight in freezer storage was negligible, averaging less than 1% even after a year's storage. Visual appearance indicated that the seasoned sausage had darkened with age whereas all unseasoned samples were still bright after a year. The seasoned sausage without MSG appeared to have a slightly stronger odor than the seasoned with MSG. The unseasoned sausage appeared to have a much fresher odor after a year's storage. Table 1 gives the results of the palatability panel.

TABLE 1

Palatability scores on frozen sausage

Month after freezing	Sample treatment					
	Control	Seasoned	Not seasoned plus 0.1% MSG	Seasoned plus 0.1% MSG	Not seasoned plus 0.3% MSG	Seasoned plus 0.3% MSG
2	5.9	5.1	5.8	5.1		
3	5.4	5.6	5.9	5.9		
4	5.6	4.1*	5.9	6.2		
5	5.7	3.5**	6.5	6.0		
6	5.6	3.6**	5.8	4.2		
7	4.5	3.1**	5.5	4.9	5.3	5.5
8	4.5	2.0**	4.8	5.8	5.8	5.5
9	5.3	3.0**	5.2	5.6	5.1	5.9
10	5.1	3.5**	5.8	4.7	4.7	5.0
11	4.8	3.9	4.1	4.9	4.5	4.8
12	4.8	3.2**	4.9	5.6	5.3	5.8

* Significant at 0.05 level.
** Significant at 0.01 level.

In all cases, after 4 months' storage the seasoned sausage without MSG was less desirable than either the seasoned plus MSG, the unseasoned control or the unseasoned plus MSG. These differences were significant or highly significant at all periods except at the eleventh month. This perhaps can be explained because some of the veteran taste panel members could not participate; consequently, there was more variability among tasters.

Data were further analyzed without using group 2 (the seasoned sausage without MSG). There were no significant differences among the groups except at the sixth month when the seasoned plus 0.1% MSG group was significantly less desirable. As this occurred only once little significance is indicated. Therefore, these data show that unseasoned sausage, unseasoned sausage with MSG, or seasoned sausage plus MSG are similar in acceptability for as long as a year in freezer storage. Although the control and the MSG treated samples were less desirable after several months' storage they were still very acceptable after a year, whereas the seasoned group without MSG was unsatisfactory after 4 to 5 months.

The addition of 0.3% MSG instead of the 0.1% had little effect upon the desirability.

SUMMARY AND CONCLUSIONS

Sausage was prepared in six ways. One group was an unseasoned control; one group was seasoned; two groups were not seasoned but contained 0.1% and 0.3% respectively of monosodium glutamate, and two groups were seasoned and also contained 0.1% and 0.3% respectively, of monosodium glutamate. The sausage was frozen and then subjected to a taste panel each month after 2 months' storage, all sausage being seasoned and kneaded alike before being cooked.

The addition of monosodium glutamate to seasoned sausage significantly increased the desirability of the sausage after 4 months' storage. Little difference was detected between the unseasoned control and the seasoned and unseasoned groups when monosodium glutamate was added. The addition of 0.3% instead of 0.1% monosodium glutamate was of no additional advantage.

Although there seemed to be some deterioration in quality, all groups treated with monosodium glutamate were very acceptable after a year of storage, whereas the seasoned sausage without monosodium glutamate was much less desirable even after 4 months of storage.

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Effects of Temperature and Air Velocity on Rate of Freezing of Commercial Bread[a]

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Preservation of the quality of oven-fresh bread by freezing may be an imminent development in the wholesale baking industry, but successful application of the process will require a careful selection of freezing methods and equipment. The present investigation demonstrates some of the important principles and provides information for reference.

Freezing appears to be a method whereby the flavor, aroma, and texture of fresh bread can be maintained for an indefinite period. There are few measures that can otherwise be taken to stabilize the particular appeal of oven-fresh bread; deteriorating changes begin as soon as bread leaves the oven and continue at a rapid rate. Staling, as indicated by changes in physical properties, is greatest during the first day after baking. Under current practices, commercially produced bread is delivered to retail stores 12-24 hours after it is baked, thus depriving the consumer of bread near its height of quality.

The freezing of baked goods, including bread, is practiced widely by retail bakers; but, with one or two exceptions, the wholesale baking companies have yet to adopt the practice. One large concern currently freezes a premium-type bread for distribution over a wide area *(1)*. Another utilizes freezing in the marketing of soft rolls, sweet yeast-goods, and cakes—but not bread. A major deterrent to the wholesale freezing of most breads is the relatively high cost of freezing and storage for such a bulky, low-cost item. Fortunately, accompanying advantages can offset to a large extent the costs of freezing bread on a wholesale basis. Depending upon the methods of merchandising, losses from staling can be reduced or, ideally, completely eliminated. Production schedules can be smoothly adapted to a five-day work week and extended lines of distribution. Unexpected fluctuations in sales volume can be absorbed with little or no loss of either goods produced in surplus or of sales lost because of an inadequate supply of freshly baked goods. Nevertheless, efficient utilization of the freezing preservation of bread requires careful selection and study of freezing methods and equipment.

There is little doubt that bread should be frozen as rapidly as possible to preserve the utmost of its original quality. Early work, as reviewed by Cathcart and Luber *(2)*, showed that the rate of increase in firmness of bread crumb accelerates with decreasing temperatures until the freezing point is reached, at which point such changes are presumably arrested. More recent reports *(5, 6)* agree that bread temperatures should pass through "the critical staling range" (65 to 20° F.) as quickly as possible during both freezing and thawing to minimize firming changes. The flavor and aroma of fresh-frozen bread after thawing, however, have been stated to be nearly, if not entirely, equal to those of the original bread *(2, 3, 6, 7)* held for moderate lengths of time even though the freezing and thawing might have caused the former to become appreciably firmer.

Interest in the preservation of bread by freezing is expanding rapidly, but factual information in the literature on freezing rates and conditions is somewhat fragmentary. Cathcart and Luber *(2)* and Cathcart *(3)* found that wrapped bread froze appreciably faster at —35° C. than at —22° C. in either still air or in a forced-draft freezing tunnel. Unwrapped bread froze faster than wrapped bread, particularly at —35° C. under forced draft. Walker *(6)* recently presented time-temperature curves for the freezing of wrapped bread under a number of conditions chiefly concerned with freezer temperature and packaging.

The present paper describes an investigation of the influence of freezer temperature and air velocity on the rates at which bread freezes. Information concerning the effects on bread quality of different freezing, thawing, or storage conditions is not included at this time but will be reported later. The results presented below illustrate some of the important principles and provide technical reference information for those interested in commercial freezing of bread.

METHODS AND MATERIALS

The freezing experiments were conducted in an experimental blast freezer in which both temperature and air velocity could be controlled over a range of conditions. Velocities between 200 and 1300 ft. per min., as measured by a pinwheel anemometer in the empty chamber, could be obtained at temperatures down to about —40° F. Separate test chambers in the freezer permitted the use of either horizontal cross-flow or vertical through-flow air blasts.

Temperatures of the bread were determined by means of duplicate, 30 gauge, copper-constantan thermocouples inserted centrally into each loaf and attached to an automatic, recording potentiometer. Unless otherwise stated, bread in the freezer was supported by stainless-steel, wire-mesh trays. The freezing time used is defined as the time for the temperature at the center of the loaf to fall from 70° F. to the freezing temperature of the bread, 20° F. in most cases.

It was necessary to use unsliced bread to maintain a satisfactory uniformity and reproducibility of temperature readings

[a] Contribution from Western Utilization Research Branch, Albany, California, Agricultural Research Service, U. S. Department of Agriculture.

in replicate runs. With sliced loaves, contraction of the bread during freezing sometimes caused individual slices to warp or curl so as to form channels into the interior of the loaves which caused irregularities in the temperature readings. Except for such irregularities, sliced bread would be expected to freeze at the same rate as unsliced bread in commercial practice; average freezing times for sliced and unsliced loaves under the same conditions were observed in several runs to be practically equal. Most experimental runs included both unwrapped loaves and loaves wrapped in the usual waxed paper wrapper.

One and one-half pound (actually 22.5 oz.) loaves of commercial, white, pan bread were selected for initial study because they represent the principal product of the wholesale baking industry, but a few experiments with other types of bread were also included. Bread obtained from two different baking companies gave essentially identical results and was used interchangeably. Most experiments were run at least twice and with duplicate loaves in nearly every instance.

RESULTS

Effect of freezer temperature. The results plotted in Figure 1 show the effect of freezer temperature, at an intermediate air velocity, on the rates of freezing of wrapped bread. The loaves were placed with their long dimension parallel to the cross-flow air stream. The horizontal portion of the curve obtained with a freezer temperature of 10° F. indicates that the freezing temperature of bread is 20° F., or slightly below. When the bread froze more rapidly at the lower freezer temperatures, the apparent freezing point was progressively lower. Supercooling is believed to contribute to this phenomenon and is discussed further in a later section.

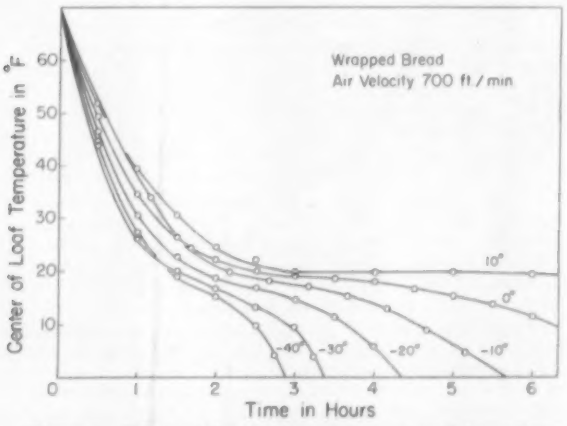

Figure 1. Effect of freezer temperature at an intermediate air velocity on rate of freezing of wrapped bread.

As expected, the time to reach the freezing point and to pass through the freezing zone was decreased when lower freezer temperatures were used. At —40° F., for instance, the temperature at the center of the loaf reached the freezing point in one-half the time required at 10° F. The differences in cooling rates at the various freezer temperatures were much greater below than above the freezing zones because differences in the cooling forces had become proportionally larger. For example, with a freezer temperature of 10° F. the cooling force decreased from 60 Fahrenheit degrees (70°-10° F.) at the start of the experiment to 10 Fahrenheit degrees (20°-10° F.) at the time the freezing point was reached. With a freezer temperature of —40° F. the cooling force decreased from 110 Fahrenheit degrees [70°-(—40°)] to 60 Fahrenheit degrees [20°-(—40°)], a cooling force that was then six times as large as that when the 10° F. freezer temperature was used.

Results for upwrapped bread under the same freezing conditions used above are shown in Figure 2. The results are similar to those obtained with wrapped bread except that at equal

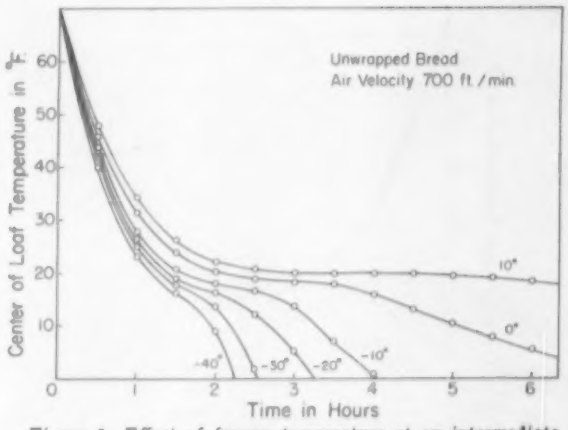

Figure 2. Effect of freezer temperature at an intermediate air velocity on rate of freezing of unwrapped bread.

freezer temperatures unwrapped bread was cooled to the freezing point 15 to 30 minutes sooner. Removing the wrapper from a loaf of bread had an effect approximately equal to a decrease of 10° F. in freezer temperature. Similar relationships between the freezing times of wrapped and unwrapped bread were found when the comparisons at different temperatures were made with an air velocity of 200 ft. per min. (Figures 3 and 4). This rate of air movement was the closest approach to still-air or "sharp" freezing used in these experiments.

The steady increase in freezing rate for each small decrease in air temperature down to the lowest freezer temperature used

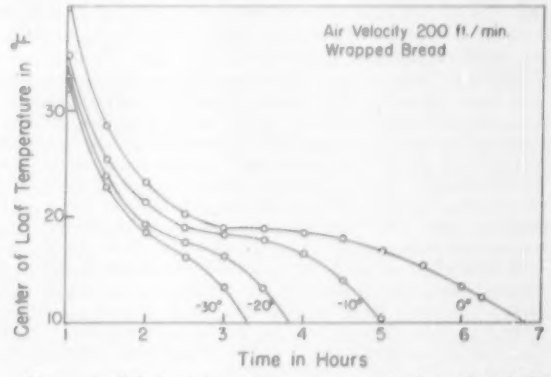

Figure 3. Effect of freezer temperature at a low air velocity on rate of freezing of wrapped bread.

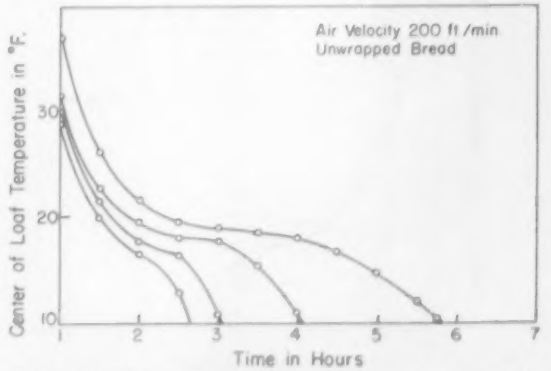

Figure 4. Effect of freezer temperature at a low air velocity on rate of freezing of unwrapped bread.

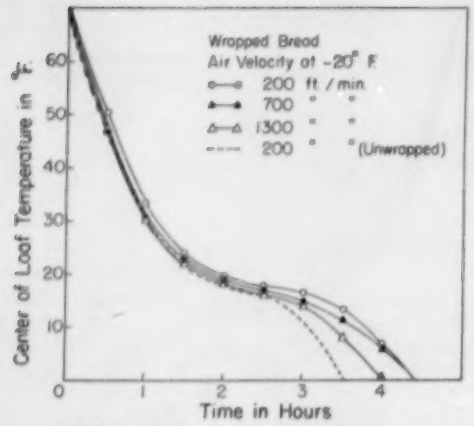

Figure 5. Effect of air velocity at low temperature on rate of freezing of wrapped bread.

confirms the observation of Cathcart *(3)* and indicates that transfer of heat through the bread is less of a rate-limiting factor than might be expected in view of the porous, cellular structure of bread crumb.

Effect of air velocity. The small effect of air velocity on the freezing times for wrapped bread is demonstrated in Figure 5. Apparently, the rate of transfer of heat from the loaf is more dependent on the wrapper and the adjacent dead-air space than on the movement of air outside the wrapper. With unwrapped bread, however, air velocity has more effect. A significant decrease in freezing time was found (Figure 6) when the velocity was raised from 200 to 700 ft. per min., but a similar decrease in time was not obtained when the velocity was raised to 1300 ft. per min. The broken line in both figures emphasizes this difference in the freezing of wrapped and unwrapped bread.

Effect of loaf position. Although a distinct but not particularly large advantage was shown above for freezing bread unwrapped and oriented parallel to the direction of the air flow, Figure 7 indicates that an additional advantage can be gained by placing the long dimension of an unwrapped loaf crosswise to the air stream. Time-temperature curves for loaves parallel to the direction of the horizontal air blast show small increases in freezing rates with increasing air velocity (Figure 6). The time-temperature curves for loaves crosswise (in a single row) to the direction of air flow show that pronounced increases in freezing rates were obtained as air velocity was increased. The most outstanding result was obtained with a blast velocity of 1300 ft. per min. In fact, lowering the freezer temperature 10° F. (to —30° F.) at this velocity hardly changed the freezing rate.

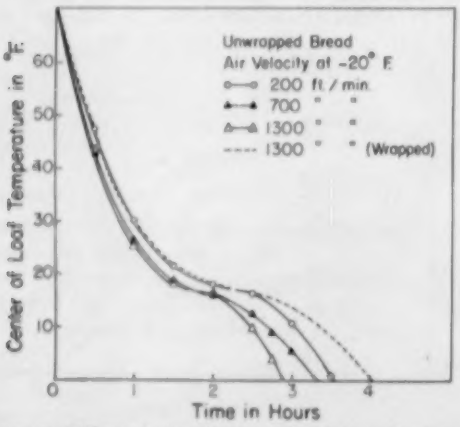

Figure 6. Effect of air velocity at low temperature on rate of freezing of unwrapped bread.

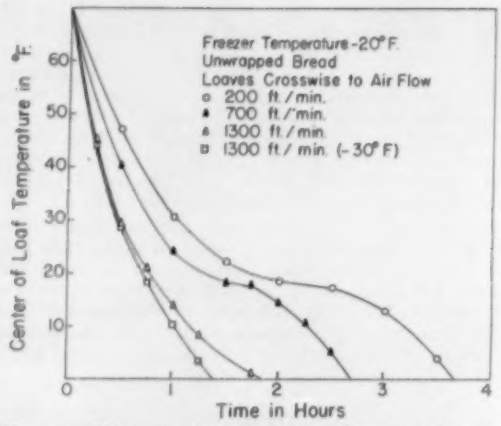

Figure 7. Effect of a crosswise loaf position and air velocity at low temperatures on rate of freezing of unwrapped bread.

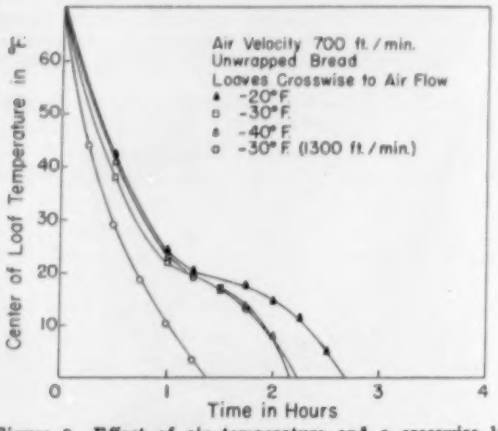

Figure 8. Effect of air temperature and a crosswise loaf position at intermediate and high air velocities on rate of freezing of unwrapped bread.

The results shown in Figure 8 likewise show that high air velocity at a low temperature is more effective than low temperature itself for freezing bread rapidly, providing the bread is unwrapped and the loaves are placed crosswise to the horizontal air flow.

Equally rapid rates of freezing with high air velocities were obtained when bread was frozen with a vertical, through-flow air blast. With this method, the bread was placed on perforated metal shelves, and the air blast entered the test chamber from below. When as many as 15 loaves were placed on each of two shelves, one above the other, the freezing times for five of the six loaves containing thermocouples were equal to those obtained when only five loaves, in all, were placed in the chamber. Loaves on the upper shelf froze as fast as those on the lower shelf under these conditions. The force of air rising through the chamber (at approximately 1200 ft. per min. as measured in the empty chamber) was nearly sufficient to lift individual loaves from the shelf. A limitation on the velocity with which air can be applied to bread from below is thus indicated, unless provision is made to hold the loaves in place on the shelves such as by placing a rigid upper shelf on top of the bread as well as beneath it.

Regions in the crumb one inch directly beneath the crust area of the side facing a horizontal air blast were found to freeze faster than those one inch beneath crust areas on the opposite (back) side of a loaf oriented crosswise to the air flow (35 min. compared with 57 min.), as might be expected. When a loaf was oriented parallel to the direction of a horizontal air stream, however, crumb regions one inch beneath the same areas of the

side crust froze more slowly (65 min.). These results indicate that large differences exist in the air stream pattern around loaves in the two positions which account for the effect of loaf position on freezing rate.

Loss of moisture. To determine the loss of moisture from unwrapped loaves during freezing by means of high velocity air (1200 ft./min.) at —20° F., ten *freshly baked*, unsliced, 22.5 oz. loaves were weighed individually before freezing and at several intervals after being placed in the freezer. The frozen loaves were weighed in the freezer itself to avoid condensation of moisture from room air on the frozen bread. At the end of five hours in the freezer, the unwrapped loaves had lost an average of only four grams of moisture each. Subsequent loss of moisture during storage, unwrapped, at 0° F. amounted to an average of 28 grams per loaf at the end of 14 days—approximately 4% of the original weight. It is therefore indicated that unwrapped bread may be frozen without significant loss of moisture but that a protective wrapper must be used to prevent serious loss of moisture during subsequent storage.

The relative humidity of the air inside the freezer during the above experiment was not measured, but because the evaporating-coil of the freezer used is large compared to its over-all size, the difference in temperature between the air and the surface of the coil was relatively small, resulting in a comparatively small drying effect on the air itself. However, even at low relative humidities, the moisture-holding capacity of air at the temperatures used above is small enough that moisture losses from bread during the short freezing times used would not be expected to be appreciably larger than those observed.

The contraction in volume of unsliced loaves during freezing is sufficient to cause wrappers to become quite loose. After thawing, the wrappers again fit snugly. If bread is to be frozen before slicing, wrapping machinery will have to be adjusted to allow for the expansion of frozen bread during thawing. Measurements of loaves before and after freezing showed that loaves shrank approximately 6 to 10% in girth.

Freezing rates in cartons. By way of contrast to the foregoing results, the freezing times for wrapped, unsliced bread packed in a 20-loaf, pasteboard delivery carton were determined, as shown in Figure 9. The numbers in the boxed portion of the legend indicate the positions of the test loaves and the order in which they froze. As expected, loaves in the corners and at the edges of the carton froze much sooner than those located nearer the center of the carton. The latter loaves required nearly twice as long to reach the freezing point as those frozen most rapidly. Approximately five hours were required for the first loaves in the carton to reach the freezing point, whereas only two hours were required for separate loaves under the same freezer conditions but without the insulating effect of the carton (see Figure 1).

The shape of the curves for loaves 7 through 10 is of particular interest.[b] In each instance and at different times, an upward inflection in the curves occurred after an apparent freezing temperature was reached. The temperature then rose to the true freezing point before again declining after the freezing zone was passed. This is direct evidence that supercooling occurred in the bread crumb as it froze. These results are parallel to the findings of Lusena and Cook *(5)* who describe supercooling caused by added salts and sugar in model systems composed of gelatin jellies.

Freezing rates of variety breads. Freezing curves for a few variety breads are shown in Figure 10. One-pound loaves (15 oz.) of each type of bread were used in this experiment. The loaves were supported on wire-mesh shelves and oriented parallel to a horizontal cross flow of air. It was rather surprising to observe that 100% whole wheat bread froze no faster than white bread despite a large difference in loaf density. The white loaves had an average density of 0.18 g. per cc. (2375 cc. average volume), and the whole wheat 0.22 g. per cc. (1965 cc. average volume).

[b] For purposes of clarity, only curves 9 and 10 are shown in Figure 9.

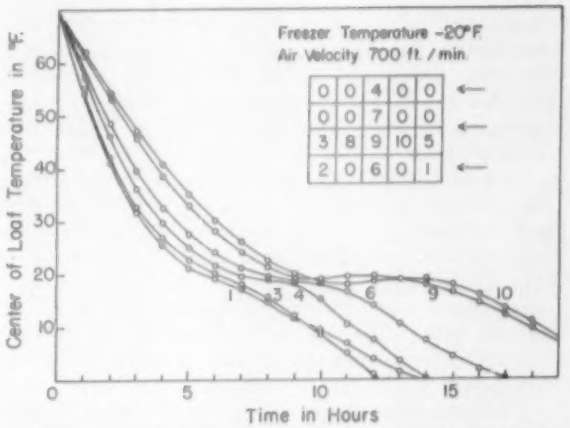

Figure 9. Rate of freezing of wrapped bread packed in a pasteboard delivery carton at low temperature and intermediate air velocity. Numbers indicate position of test loaves in carton and order in which they froze. Arrows indicate direction of air flow.

Apparently, differences in factors such as surface area, cross-sectional dimensions, specific heat and thermal conductivity of the crumb, etc., compensated each other in this instance so as to result in equivalent freezing rates for the two types of bread.

Raisin bread cooled slightly faster than white or whole wheat bread and appeared to freeze at a lower temperature. Even allowing for a certain amount of supercooling and distortion of the freezing plateau, there seems little doubt that the true freezing point of raisin bread is lower than that of white bread (compare with Figure 2). In fact, in a separate determination, the freezing temperature of raisin bread was found to be 15° F. The lower freezing point of the raisin bread is probably due to the larger amount of sugar in the formula, just as the absence of sugar and milk in the sour French bread is responsible for its higher freezing point (22° F., as determined in a separate experiment). The French bread probably froze so much faster than the other breads in this case because of its longer, narrower shape and consequent smaller cross-sectional area.

DISCUSSION

It is recognized that the experiments described above were conducted under somewhat idealized laboratory conditions and probably would not be exactly duplicated in actual commercial practice. They do illustrate the

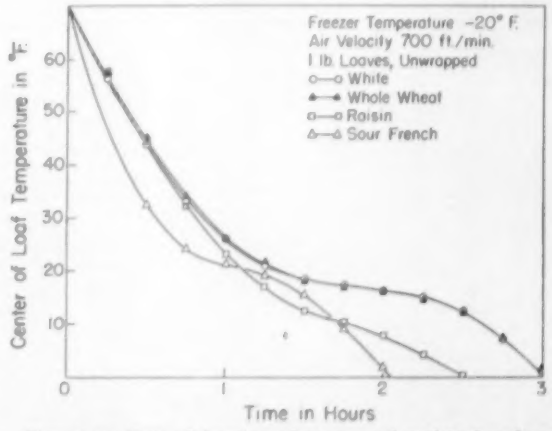

Figure 10. Rate of freezing of unwrapped variety breads at low temperature and intermediate air velocity.

changes in freezing rates that may be expected with changes in freezing procedures, however; and the principles demonstrated and the general information provided should aid in the selection of methods and equipment by those interested in freezing bread on a wholesale basis.

Because costs of operation and equipment increase markedly as air velocity is increased and air temperature decreased, gains in the retention of original quality obtained by freezing bread with the most rapid methods may not be justified economically. An investigation of the extent to which the original quality of bread can be affected by variations in freezing, storing, and thawing procedures is in progress at this laboratory, and the results will be presented separately.

To freeze bread before slicing and wrapping deviates from conventional commercial practice, but the greater rapidity of freezing and the more effective retention of original quality may justify serious practical consideration of the method. Slicing and wrapping of the frozen loaf may present problems with respect to proper blade selection, adjustment of wrapping tension, etc., but both operations appear entirely feasible. A loose wrap would be necessary because bread shrinks perceptibly during freezing. Moisture losses during exposure to the air blast in the present experiments were negligible, but the need was indicated for a suitable wrapper to prevent serious loss of moisture during storage at low temperatures for more than a few days.

SUMMARY

Freezer temperature was found to be the variable with greatest effect on freezing rate of wrapped bread. With unwrapped bread, air velocity and position of the loaf in the air blast were factors of major importance. The most rapid method of freezing bread in the present experiments was by means of a high-velocity, low-temperature blast of air at right angles to the long dimension of an unwrapped loaf. Individual loaves could be frozen in less than 30 minutes by this method, and no significant loss of moisture was incurred.

The wrapper on a loaf of bread slowed the rate of freezing about as much as using a freezer temperature 10° F. higher. Wrapped bread packed in pasteboard cartons froze several times more slowly than individual loaves under similar freezer conditions.

Whole wheat bread froze at the same rate as white bread despite a substantial difference in loaf density. Raisin bread froze at a lower temperature than white bread, and sour French bread at a higher temperature, as would be expected from the differences in composition. The French bread froze more rapidly than other breads because of its loaf shape.

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Fatty Acid Composition, and Oxidative Deterioration During Storage, of Fats in Cuts of Beef, Lamb, Pork, and Turkey[a,b]

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The effect of two different feeding regimens and storage at two low temperatures for extended periods on fatty acid composition in two types of uncooked cuts from pork, beef, lamb, and turkey was determined.

The fatty acid composition of the pork, beef, and lamb cuts was determined at intervals during storage at 4° F. (—15.6° C.) and 33° F. (0.6° C.), and of turkeys at intervals during storage at 0° F. (—17.8° C.) and 10° F. (—12.2° C.) to follow changes caused by oxidative deterioration. Although all cuts became unacceptable after prolonged storage because of proteolytic changes in the meat stored at 33° F., and rancidity in the meats stored at 0°, 4°, and 10° F., only the surface fat appeared to have been oxidized and overall losses of essential fatty acids were generally insignificant from a nutritional point of view, except for possible toxicity hazards from rancid fat.

Many of the undesirable flavor changes that occur in meats and poultry during prolonged storage at low temperatures are attributed to oxidative changes in the fat *(1, 8, 11, 12, 13, 18)*. Storage conditions which reduce exposure of the meat to atmospheric oxygen have been used with some success to prolong storage life *(14, 15, 16, 26)*. However, it is known that the composition of the diet and the nature of the dietary fat are factors which affect both fatty acid composition *(1, 4, 5, 9, 11)* and antioxidant content *(3, 18)* of body fats of various animals, and thus affect the stability of cuts from the carcasses of such animals during low temperature storage.

The essential fatty acids, linoleic, linolenic, and arachidonic acids, or their esters, appear to be nutritionally desirable in the human diet *(6, 7, 24)*. Since they are more susceptible to oxidation than oleic, palmitic, and stearic acids, it appeared important to determine the extent of their destruction by oxidation during prolonged storage of meat at low temperatures.

More specifically, this investigation was concerned primarily with the oxidative deterioration of certain fatty acids in the fats of pork, beef, lamb, and turkey. Two representative meat cuts from animals representing two different dietary histories from these four species were stored at two low temperatures in each case.

EXPERIMENTAL

Production and Processing of Animals

Pork. Two weanling Chester White pigs at 8 weeks of age were placed *ad libitum* on ecah of the two diets shown in Table 1, raised to weights of approximately 200 pounds, and then slaughtered and dressed.

TABLE 1

Rations

Ingredients	Hogs[2] Diet A	Hogs[2] Diet B	Beef[1] Diet A	Beef[1] Diet B	Lamb[1] Diet A	Lamb[1] Diet B
	%		*lbs.*		*lbs.*	
Barley		75.5				
Yellow corn	72.5		20.0[3]		2.0	
Tankage	8.0	5.0				
Soybean oil meal	12.0	12.0	2.0	2.0	0.2	
Dehydrated alfalfa leaf meal	5.0	5.0				
Steam bone meal	1.0	1.0				
Lime	1.0	1.0				
Salt	0.5	0.5				
Chopped timothy hay			3.0	10.0	0.5	4.0
Silage			3.0	4.0		
Minerals			free choice		free choice	
Oats					0.5	0.5

[1] Daily rations.
[2] + ½ lb. yeast per 1000 lbs. feed.
[3] Corn gradually increased up to 20 lbs.

Beef. Four steers averaging 676 pounds were fed the diets shown in Table 1 for 159 days, 2 steers on each diet. The animals fed the fattening ration (diet A) consumed an average of 3562 pounds of feed plus 30 pounds of mineral mix before slaughter and gained an average of 367 pounds each, whereas the animals on the maintenance ration (diet B) consumed an average of 4117 pounds of feed and 30 pounds of mineral mix and averaged 234 pounds of gain each.

Lambs. Six lambs averaging 75 pounds each were placed in groups of 3 on the two diets shown in Table 1 and slaughtered 66 days later. The lambs fed the fattening diet (diet A) averaged 101⅔ pounds at slaughter, and those fed the maintenance diet (diet B), 98 pounds. The carcasses of the animals on the fattening ration were graded *choice*, and those of animals on the maintenance ration, *good*.

Turkeys. Twenty Broad-Breasted Bronze turkey hens were raised by the Poultry Division, the University of Minnesota, for this study. All birds received the starter ration shown in Table 2 for 10 weeks; 10 birds were kept in confinement on wire and

TABLE 2

Turkey rations

Ingredients	Diet A (starter ration)	Diet B (growing ration)
	lbs.	*lbs.*
Ground yellow corn	220	270
Wheat bran	100	100
Wheat middlings	100	150
Pulverized oats	100	150
Alfalfa meal	25	50
Meat and bone scraps (50%)	100	100
Soybean oil meal	250	150
Fish meal	30	20
Oyster shell	15	5
Salt, iodized	5	5
Riboflavin concentrate (B. Y. 500)[1]	5	5
APF[2]	0.25	0.25
A and D feeding oil[3]	2	....
Dry D_3[4]	0.5	0.5
Manganese sulfate (Techmangan)	0.25	0.25

Whole oats and shell corn fed free choice with growing ration

[1] 227 mg./lb.
[2] Merck no. 3, 12.5 mg. B_{12}/lb.
[3] 400 D, 3000 A.
[4] 981,000 units/lb.

[a] Hormel Institute publication no. 109.
[b] Supported in part by the U. S. Department of Agriculture through a contract sponsored by the Human Nutrition Research Branch, Agricultural Research Service.

were given the growing diet (Table 2) for 14 weeks *ad libitum*. The remaining 10 birds were given the same growing ration *ad libitum*, but were also permitted to run and feed on rape pasture. At the end of the growing period the birds were slaughtered and dressed at a commercial eviscerating plant. The 10 birds in the confinement group averaged 12.47 pounds dressed weight, excluding giblets. One of the birds in the rape pasture group was found to be fevered at slaughter and was discarded. The remaining 9 birds in this group averaged 11.47 pounds dressed weight, excluding giblets.

Storage and Sampling of Meats

Pork. The Boston butts and pork loins from the hogs were wrapped individually in brown locker wrapping paper, and one of each of these cuts from each of the 4 animals was stored at 4° F. (—15.6° C.) and 33° F. (0.6° C.).

For analysis, samples of 1 to 2 inches in thickness were sliced from each cut. Some slices were taken from the ends and at other times end slices were discarded and other slices taken which had not previously been exposed on either side. The thickness of the slices was variable depending on the relative amounts of lean, fat, and bone. Weights of the samples were generally about 300 or 400 g. After a sample had been taken, the remainder of the cut was rewrapped and stored.

Beef. Shoulder and round from each of the 4 animals were cut into approximately 2-pound samples, individually wrapped in brown locker wrapping paper, and stored at 4° F. (—15.6° C.) and 33° F. (0.6° C.). At intervals an entire package was taken for analysis.

Lambs. Entire legs and shoulders of lamb were packaged and stored at 4° F. (—15.6° C.) and 33° F. (0.6° C.). At appropriate intervals samples of several hundred grams were removed for analysis in a manner analogous to the procedure followed for pork, except that the corresponding cuts from the different animals in a group were pooled before analysis.

Turkeys. The dressed turkeys were quartered, quick-frozen, and placed in Cry-O-Vac bags. One half of the breast and leg quarters from carcasses for each diet were stored at 0° F. (—17.8° C.), and the remainder stored at 10° F. (—12.2° C.). At appropriate intervals sample quarters were removed from storage for analysis.

In turkeys, skin and subcutaneous fat contained a major portion of the total fat of the cuts as ordinarily served at the table. Moreover, it is primarily the fat in the skin, subcutaneous fat, and surface fat in the abdominal cavity that undergoes oxidative deterioration during low temperature storage. Analyses on turkeys were therefore generally conducted on samples taken from the skin and subcutaneous fat after separation from the lean.

General Analytical Procedures

The pork, beef, and lamb samples taken as described above were weighed intact, the meat separated from the bone, and ground in a meat grinder to give a sample of uniform composition. Moisture was determined on representative samples weighed into aluminum dishes with loose-fitting covers *(19)*. Total nitrogen was measured on most samples by a standard method *(20)*. The fat content was determined by extracting a sample of the ground meat with chloroform in a Waring blender *(25)*. Purified nitrogen was bubbled through the solution in the blender to avoid oxidation of the fat. The fat was recovered from the filtered and dried chloroform solution by evaporation of the solvent using reduced pressure.

It should be emphasized, however, that the data for total fat, moisture, and protein given in Tables 3, 4 and 5 do not lend themselves to establishing anything more than an uncertain estimate of the composition of meat cuts obtained under varied conditions. The principal objective in this work was to study oxidative deterioration in the fats of representative meat cuts during low temperature storage; the determination of more

TABLE 3

Analyses of pork loin and butt samples at the beginning and end of storage tests

Analysis	At start of storage test				After 60 days at 33° F.(0.6° C.)				After 479-501 days at 4° F. (—15.6° C.)			
	Diet A		Diet B		Diet A		Diet B		Diet A		Diet B	
	Loin	Butt	Loin	Butt	Loin	Butt	Loin	Butt	Loin	Butt	Loin	Butt
% fat	22.8	34.1	23.8	21.8	.....	.....	.....	.....	25.4	24.3	30.0	24.4
% moisture	61.1	52.1	60.0	62.2	.....	.....	.....	.....	57.2	59.3	53.6	58.1
% protein	16.1[1]	13.8[1]	16.2[1]	16.0[1]	.....	.....	.....	.....	17.4	15.9	16.4	17.2
Analyses of fat (fatty acids expressed as % by weight of total fatty acids)												
Peroxide value m.e./kg.	0	0	0	0	2.36	1.38	1.01	1.14	16.4	5.0	53.0	8.0
Iodine value, fatty acids	62.0	66.0	61.6	65.4	60.5	66.2	60.0	66.8	59.2	65.6	59.6	66.2
% conj. dienoic fatty acids	0.16	0.17	0.14	0.15	0.13	0.15	0.15	0.20	0.25	0.18	0.28	0.15
% saturated fatty acids	42.1	40.3	44.7	40.8	45.6	44.0	44.4	39.1	44.6	39.4	47.2	36.9
% oleic acid	48.4	47.6	43.4	47.3	42.9	45.1	46.0	49.1	46.4	49.8	41.0	53.7
% linoleic acid	8.32	10.8	10.8	10.9	10.6	12.3	8.54	10.4	8.0	9.6	10.7	8.6
% linolenic acid	0.42	0.54	0.34	0.44	0.34	0.35	0.48	0.54	0.39	0.52	0.48	0.35
% arachidonic acid	0.55	0.56	0.49	0.52	0.47	0.64	0.48	0.63	0.44	0.55	0.48	0.37

[1] Determined by difference.

TABLE 4

Analyses of beef round and shoulder samples at the beginning and end of storage test

Analysis	At start of storage test				After 90 days at 33° F. (0.6° C.)				After 905 days at 4° F. (—15.6° C.)			
	Diet A		Diet B		Diet A		Diet B		Diet A		Diet B	
	Round	Shoulder	Round	Shoulder	Round	Shoulder	Round	Shoulder	Round	Shoulder	Round	Shoulder
% fat	16.2	30.7	13.9	16.7	.....	.....	.....	.....	18.8	29.1	17.6	18.0
% moisture	65.6	55.4	68.6	66.2	.....	.....	.....	.....	58.6	50.2	60.8	62.2
% protein	18.2[1]	13.9[1]	17.5[1]	17.1[1]	.....	.....	.....	.....	22.2	20.6	21.6	20.0
Analyses of fat (fatty acids expressed as % by weight of total fatty acids)												
Peroxide value, me./kg.	0	0	0	0	0	0	0	0	26.1	17.4	26.0	12.1
Iodine value, fatty acids	53.9	51.6	45.6	42.6	52.3	51.3	45.5	42.8	53.2	52.7	48.6	46.3
% conj. dienoic fatty acids	0.56	0.50	0.61	0.60	0.64	0.57	0.70	0.64	0.56	0.50	0.71	0.58
% saturated fatty acids	43.2	45.6	52.7	57.6	45.2	46.2	53.2	56.1	44.4	45.6	49.3	52.0
% oleic acid	54.4	52.1	44.8	41.2	52.2	51.2	44.0	41.3	53.2	53.2	48.2	45.4
% linoleic acid	1.42	1.42	1.10	1.12	1.42	1.44	1.22	1.16	1.40	1.46	1.11	1.24
% linolenic acid	0.34	0.37	0.58	0.68	0.42	0.42	0.72	0.58	0.34	0.34	0.47	0.44
% arachidonic acid	0.11	0.09	0.14	0.20	0.10	0.13	0.14	0.20	0.12	0.56	0.23	0.25

[1] Determined by difference.

TABLE 5

Analyses of lamb leg and shoulder samples at beginning and end of storage test

Analysis	At start of storage test				After 100 days at 33° F. (0.6° C.)				After 1025 days at 4° F. (−15.6° C.)			
	Diet A		Diet B		Diet A		Diet B		Diet A		Diet B	
	Leg	Shoulder	Leg	Shoulder	Leg	Shoulder	Leg	Shoulder	Leg	Shoulder	Leg	Shoulder
% fat	22.9	26.7	18.1	27.2	.....	.....	.....	.....	14.1	24.6	13.2	36.9
% moisture	60.4	57.8	64.9	57.2	.....	.....	.....	.....	65.3	56.6	65.5	45.0
% protein	16.7[1]	15.5[1]	17.0[1]	15.6[1]	.....	.....	.....	.....	20.4	18.3	20.8	16.9
Analyses of fat (fatty acid composition expressed as % by weight of total fatty acids)												
Peroxide value, m.e./kg.	0	0	0	0	0	0	0	0	5.4	3.7	5.4	2.0
Iodine value, fatty acids	52.3	55.7	46.9	51.7	60.4	59.2	47.6	50.8	55.5	53.8	48.1	48.0
% conj. dienoic fatty acids	0.85	1.12	1.01	1.31	0.90	0.94	1.08	1.12	1.18	1.6	1.83	1.27
% saturated fatty acids	49.1	45.3	53.1	48.0	40.9	42.3	52.1	48.7	45.1	48.2	52.9	52.0
% oleic acid	44.7	48.6	42.7	47.5	51.4	50.7	43.8	47.3	49.4	45.1	42.0	43.6
% linoleic acid	4.70	4.28	2.54	2.45	5.99	5.31	2.30	2.21	3.51	4.24	2.39	2.28
% linolenic acid	0.39	0.47	0.46	0.52	0.36	0.38	0.41	0.38	0.27	0.44	0.30	0.45
% arachidonic acid	0.27	0.28	0.27	0.27	0.36	0.37	0.29	0.36	0.54	0.48	0.55	0.32

[1] Determined by difference.

accurate "mean" values for the absolute contents of fat, moisture, and protein in pork, beef, and lamb in general, and their changes during storage, would require a project of far greater scope and magnitude, and with more detailed attention to sampling methods.

The fat was analyzed for peroxide content by an iodometric method *(23)*. The Wijs iodine value was also determined *(21)*. Following saponification and removal of unsaponifiable matter, the total fatty acids were analyzed for their fatty acid composition by the spectrophotometric method of Brice, Swain, Schaeffer, and Ault *(2)*. Since oxidized fat causes errors in the determination of fatty acid composition by alkali-isomerization-spectrophotometric methods, it was removed by a countercurrent extraction procedure—in a method of analysis that has been described in detail elsewhere *(22)*—before analysis was made on some of the more highly oxidized samples.

Similar procedures were employed throughout in analyzing the skin and subcutaneous fat depots of the turkey leg and breast quarters, except that measurements of total nitrogen were not made.

With pork and beef, duplicate analyses on corresponding samples from each of the 2 animals fed each diet were averaged (Tables 3 and 4, respectively). In lambs, corresponding samples from 3 lambs fed each diet were composited and duplicate analyses on the composited samples were made (Table 5). With turkeys, duplicate analyses were made on single samples (Table 6).

In general, duplicate results for fat and moisture determinations agreed within 2% or less; duplicate values for iodine values and peroxide values agreed within 1% or less; duplicate determinations of fatty acid composition agreed within 2% except in the case of fatty acids that were present in very small amounts, where deviations as high as 5% were encountered in duplicate analyses.

RESULTS AND DISCUSSION

The primary objective of this investigation was to obtain information on the deterioration of fatty acids in pork, beef, lamb, and turkeys during storage, but concomitant physical and chemical changes in the lean were also observed. In the storage tests at 33° F. (0.6° C.) some samples of all the meats (pork, beef, and lamb) were stored beyond the point of acceptability as food as judged by flavor and odor in informal organoleptic tests conducted on cooked samples by the laboratory personnel. Nevertheless, even at the most advanced stages of proteolytic change there was no evidence of any appreciable destruction of fatty acids. Data for these higher storage temperatures are given in Tables 3, 4, and 5 for pork, beef, and lamb, respectively.

Pork, beef, and lamb stored at 4° F. (−15.6° C.) and turkeys stored at 0° F. (−17.8° C.) and 10° F. (−12.2° C.) for long periods developed no marked proteolytic changes, but the surface fats in these samples showed definite signs of oxidative rancidity, especially in the pork and turkeys.

In general, however, even a high degree of fat rancidity (as judged by odor and flavor) did not represent any appreciable change in fatty acid composition of the samples as a whole. Because of uncontrollable factors, data obtained from corresponding samples at different time intervals are not entirely consistent. Complete data for the original samples and for samples that had been stored until unacceptable as food are therefore given as representative data which indicate the nature and magnitude of the changes between the beginning of the storage period and the point of unacceptability from the standpoint of flavor and odor.

TABLE 6

Analyses of turkey samples at the beginning and end of the storage tests

Analysis	At start of storage test				After 700 days at 0° F. (−17.8° C.)				After 680 days at 10° F. (−12.2° C.)			
	Birds in confinement		Birds on rape pasture		Birds in confinement		Birds on rape pasture		Birds in confinement		Birds on rape pasture	
	Leg	Breast	Leg	Breast	Leg	Breast	Leg	Breast	Leg	Breast	Leg	Breast
Peroxide value, m.e./kg.	0	0	0	0	9.96	13.4	21.4	32.9	361	123	43.8	337
Iodine value, fatty acids	88.6	87.9	91.3	93.0	83.8	84.2	99.1	99.0	79.2	85.0	90.7	88.7
% conj. dienoic fatty acids	0.25	0.22	0.16	0.17	0.26	0.25	0.33	0.33	1.51	0.85	0.35	1.08
% conj. trienoic fatty acids	0.02	0.02	0.02	0.01	0.01	0.0	0.02	0.03	0.02	0.03	0.01	0.02
% conj. tetraenoic acids	0	0	0	0	0	0	0	0	0	0	0	0
% saturated acids	29.9	30.7	32.4	30.3	29.6	30.6	27.0	28.3	32.2	30.2	32.1	32.0
% oleic acid	43.6	43.0	36.2	38.5	47.5	46.5	38.7	36.4	48.4	46.4	37.5	39.6
% linoleic acid	24.8	24.6	29.6	29.3	21.2	21.9	31.7	32.6	17.3	21.7	28.2	25.8
% linolenic acid	1.22	1.13	1.30	1.32	0.47	0.50	1.82	1.72	0.30	0.45	1.47	1.24
% arachidonic acid	0.23	0.33	0.41	0.40	0.27	0.29	0.35	0.52	0.19	0.34	0.35	0.28

Relation of diet to fatty acid composition. As observed by others, the type of diet had an effect on the fatty acid composition of the depot fats. The differences were not great in pork (Table 3) but were evident in the case of beef, lamb, and turkeys as shown in Tables 4, 5, and 6, respectively. The shoulders and rounds of beef from the animals fed the fattening diet contained a lower percentage of saturates and greater percentages of oleic and linoleic acids than the corresponding rounds and shoulders from the animals fed the maintenance diet. The chief difference in lamb was in the relative amounts of linoleic, oleic, and saturated acids. In the *choice* legs and shoulders of lambs the percentages of saturates were lower, of oleic slightly higher, and of linoleic almost double the corresponding percentages in the *good* shoulders and legs.

In turkeys, those allowed to run on rape pasture dressed out at significantly lower weights than those raised in confinement. There also was a difference in the amount and type of fat that was deposited in the depots (Table 6). The birds kept in confinement in general were fatter and the fat was more saturated. The fat of the birds maintained on rape pasture contained a larger percentage of the polyunsaturated fatty acids—linoleic, linolenic, and arachidonic. The oleic acid content was higher in the depot fats of the birds kept in confinement.

Results of the storage tests. Analyses of fat extracted from the pork, beef, lamb, and turkey cuts at the end of the storage periods are shown in Tables 3, 4, 5 and 6 respectively. Several general observations and conclusions were made from these tests. Compared with pork, the lipids in the beef and lamb cuts did not develop oxidative rancidity as rapidly. In fact, the lamb cuts showed considerable resistance to oxidative deterioration as indicated by the low peroxide values at the end of the storage tests (Table 5).

Most significant in this connection was the fact that the peroxide value of fat extracted from a thin slice of meat from the end of a pork loin stored for 620 days was 122 m.e./kg., compared to 12.7 for the fat extracted from a slice taken from near the center. If a square of meat had been taken from the interior of the cut of meat in such a way that no exposed surface was included, it is probable that no peroxides would have been found. It was apparent that the oxidation was limited almost entirely to the exposed surfaces of the meat.

A similar condition existed in the turkey cuts. The average peroxide value of exposed fat in the abdominal cavity of 4 cuts after 1090 days storage at 0° F. was 696 m.e./kg., as compared with values of 45 on skin fat, 24.2 on subcutaneous fat, and trace values on unexposed muscle fat.

It is also evident that under these circumstances surface dehydration may play an important role in the rate and extent of oxidation. At the end of the storage tests at 4° F. (—15.6° C.), the exposed parts of the lean of the lamb, pork, and beef exhibited the characteristic brown "met-pigment" color resulting from the oxidation of the red meat pigments hemoglobin and myoglobin to the brown colored oxidized pigments methemoglobin and metmyoglobin. As the dehydration progressed, the outer brown layer became deeper and more cork-like in structure, permitting a deeper penetration of atmospheric oxygen to take place.

Since each sample of meat was ground in order to obtain a more or less uniform sample for analysis, the peroxide values gave an indication only of the over-all destruction of the fat in the various meat cuts and did not give a true indication of the onset of rancidity in the fat. Likewise, although the diets determined to some extent the composition of the fat, and fat containing a higher percentage of unsaturation would be expected to become rancid more quickly on exposure to atmospheric oxygen, it is apparent that dietary factors played a negligible role in the overall destruction of the unsaturated fatty acids in the whole cuts; they influence the rate of deterioration of the surface fat, however. At the end of the storage tests, even though the meat of all cuts was quite inedible because of rancidity and dehydration, the overall destruction of the fatty acids was very minor, as shown in Tables 3, 4, 5, and 6.

No apparent differences were observed in the fatty acid composition of the skin and subcutaneous fats of the leg and breast cuts of turkeys on a particular diet (Table 6), and insofar as could be determined there was no difference in their relative rates of oxidation.

Like lamb, beef, and pork, the turkeys at the end of storage periods of 700 days at 0° F. (—17.8° C.) and 680 days at 10° F. (—12.2° C.) were highly rancid, but the skin and subcutaneous fats contained most of their original essential fatty acids in unaltered form, and the diminution in the essential fatty acids by oxidation at the point where the meat became unfit because of rancidity was negligible from a nutritional standpoint.

SUMMARY

Determination was made of the effects of two different feeding regimens and prolonged storage at two low temperatures on the fatty acid composition in two types of cuts from pork, beef, lamb, and turkey.

The two feeding regimens gave differences in the amount and type of fat deposited in all species except the pork.

Irrespective of species, type of cut, or type of diet, none of the meats tested were found to have undergone any appreciable oxidative deterioration of the fatty acids in storage at 33° F. (0.6° C.) under the conditions employed in this study at the point where the meat had become unpalatable because of other types of deterioration.

The fatty acid composition of pork, beef, and lamb cuts was determined at intervals during storage at 4° F. (—15.6° C.), and of turkeys at intervals during storage at 0° F. (—17.8° C.) and 10° F. (12.2° C.), to follow changes caused by oxidative deterioration. Although all cuts became unacceptable after prolonged storage because of rancidity, only the surface fats appeared to have been oxidized and overall losses of essential fatty acids were insignificant from a nutritional point of view (except for possible toxicity hazards from rancid fat).

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Evaluation of Thresholds and Minimum Difference Concentrations for Various Constituents of Wines. III. Ethyl Alcohol, Glycerol and Acidity in Aqueous Solution

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Previous work (2, 3) is continued, the effect of the presence of ethyl alcohol, glycerol, and acidity being reported in this paper. A significant tannin-sugar interaction was found, the presence of sugar tending to minimize the effect of tannin.

This paper, a continuation of previous work *(2, 3)*, covers the effect of the presence of various constituents upon the threshold and minimum detectable concentration differences for ethyl alcohol, glycerol, and acidity in aqueous solution. The concentrations of these substances normally present in wine have been discussed *(2)*. Although other alcohols are present in wine, ethyl alcohol is by far the most abundant, with glycerol in nominal quantities. The higher alcohols occur in minute amounts and are formed as a result of yeast action on non-carbohydrate precursers—in particular, amino acids *(1)*. Webb *et al. (7)*, in the determination of components comprising a typical fusel oil derived from grape brandy, identified isoamyl, isobutyl, active amyl, sec-butyl, n-propyl, n-butyl, n-hexyl and n-amyl alcohols.

Ethyl alcohol is one of the relatively few substances which has odor, a taste independent of odor, and is also a stimulus from the standpoint of chemical sensation *(6)*. Thresholds for each sensation have been given as:

0.44% by weight for odor in air
14.0% by weight for taste in air
25.0% by weight for chemical sensation in air

The work of Stoof *(6)* showed ethyl alcohol to be recognizable at a dilution of 1 in 50,000 (.002%) in water by odor alone, and about 13% by weight in water could just be detected by taste alone. Recent work *(2)* reports a threshold for alcohol of .004% by weight with the particular panel used.

Glycerol is odorless, and in the concentrations used, the taste is sweet. It is slightly sweeter than dextrose *(4)*.

METHOD

The triangular test technique *(5)* was used throughout and the methodology has been described in a previous paper *(2)*. The ethyl alcohol used was a triple-distilled neutral grape spirit

of 95.5% alcohol by volume. Sucrose was used, being equivalent to wine sugars in threshold and minimum concentration difference values, the wine sugars consisting of levulose and dextrose in approximately equal amounts *(3)*. The glycerol used was of reagent grade. To be comparable to the acidity in wine, the acidity tests were made using solutions containing mixtures of succinic, lactic, malic and tartaric acids, and potassium bitartrate in fixed proportions. All acids were of reagent grade. The tannin used was an Australian grape seed tannin assaying 67.5% tannin (AOAC *Methods of Analysis*, 6th ed., 1945).

RESULTS AND DISCUSSION

Detectable differences in concentration of alcohol were determined at 0, 10 and 15% by volume levels in aqueous solutions containing 0, 5, 10 and 15% by weight of sucrose. In Table 1, the effect of sucrose is clearly demonstrated. A greater difference in concentration of alcohol is required to be detectable with increasing sugar concentration. Increasing alcohol concentration levels also increased the necessary difference.

TABLE 1

Effect of sucrose concentration on the detectable concentration differences for ethyl alcohol

Ethyl alcohol volume %	Detectable concentration difference in alcohol at: Sucrose by weight %			
	0	5	10	15
0	.005	.15	.35	.45
10	2.0	3.0	4.0	4.0
15	3.0	4.0	4.2	4.2

The effect of acidity on detectable ethyl alcohol concentration differences was determined by employing an acid solution containing the following acids:

Succinic	.06%
Lactic	.06%
Malic	.06%
Potassium bitartrate	.30%

The total acidity of this solution was .30 g. per 100 ml. calculated as tartaric acid, with pH = 3.4. The levels of ethyl alcohol used were 0, 10 and 15% by volume in the above acid solution containing 0, 5, 10 and 15% sucrose. Table 2 gives the results of this experiment. The acidity tends to diminish the effect of sucrose to some extent (Table 1). The threshold value in .30 g. per 100 ml. acid solution (0% level alcohol) was slightly higher than in water, which was probably due to the confusing effect of the slight odor imparted by the acids.

TABLE 2

Effect of sucrose in 0.30 g./100 ml. acid solution on the detectable concentration differences for ethyl alcohol

Ethyl alcohol volume %	Detectable concentration difference of alcohol at: Sucrose by weight %			
	0	5	10	15
0	.20	.20	.45	.55
10	2.5	2.5	3.5	3.5
15	3.0	3.5	3.5	3.5

The threshold for glycerol was determined in water, acid, and alcohol solutions. The acid solutions were:

Acid No. 1	Acid No. 2	Acid No. 3
Lactic 06%	Same as No. 1,	Lactic 15%
Succinic . . .06%	but in 10%	Succinic . . .12%
Malic 06%	alcohol	Malic 20%
Potassium bitartrate . .30%		Tartaric . . .05%
		Potassium bitartrate . .30%

Calculated in g. per 100 ml. as tartaric acid, acid No. 1 contained .30, acid No. 2, .30, and acid No. 3, .60. The pH values were 3.4, 3.45 and 3.0, respectively. The results are given in Table 3. The effect of both alcohol and acidity is to increase the threshold concentration for glycerol.

TABLE 3

Effect of acid and ethyl alcohol on the glycerol threshold

Water	Glycerol threshold weight % in Acid 1	Acid 2	Acid 3	10% alcohol
0.4	1.5	1.5	1.3	1.0

The acidic thresholds and detectable concentration differences were determined for the .30 and .60 g. per 100 ml. levels, calculated as tartaric acid, in solutions containing 0, 5 and 10 g. per 100 ml. sucrsoe, ethyl alcohol at 0 and 10% by volume, tannin at 0 and .05% and combinations of these substances.

A stock solution of acids was made to contain, .80 g. per 100 ml. acid, calculated as tartaric, as follows:

Succinic	.144%
Malic	.240%
Lactic	.180%
Tartaric	.140%
Potassium bitartrate	.360%

This solution was diluted with distilled water to any desired concentration for the tests. The pH remained constant throughout all dilutions, a value of 3.0 for acidities from .30 to .72 g. per 100 ml. in water, and 3.2 for a similar range of acidities in 10% ethyl alcohol.

The effect on the acid threshold value is given in Table 4. Sucrose did not affect the detectable concentration in any concentration of sugar used. Alcohol appeared to increase the threshold concentration.

The effects of acid, tannin, sugar, and alcohol on the minimum detectable concentration of acid are given in Table 5; analysis of variance was used to test the significance of the results. A very highly significant interaction was found, tannin with sugar, and analysis of the data (Table 5) reveals that the presence of sugar tended to diminish the effect of tannin on the detectable differ-

TABLE 4

Effect of sucrose and ethyl alcohol on the acidic threshold

Alcohol vol. %	Sucrose g./100 ml.	Acidic threshold g./100 ml.
0	0	.004
0	5	.004
0	10	.004
10	0	.007
10	5	.007
10	10	.012

TABLE 5

Effect of sucrose, tannin and ethyl alcohol on detectable differences of acid (g./100 ml.)

Acid g./100 ml.	Tannin 0%						Tannin .05%					
	Alcohol											
	0%			10%			0%			10%		
	Sucrose (g./100 ml.)											
	0	5	10	0	5	10	0	5	10	0	5	10
.30	.05	.07	.06	.06	.06	.05	.10	.08	.07	.12	.07	.06
.66	.10	.10	.10	.10	.09	.10	.15	.13	.12	.16	.12	.12

ANALYSIS OF VARIANCE

	Sum squares × 10000	Degrees freedom	Mean square × 10000	F ratio
Main effects				
Acid	121.5	1	121.5	
Tannin	54.0	1	54.0	
Sugar	17.3	2	8.65	
Alcohol	.1	1	.1	
First order interactions				
Acid × tannin	1.5	1	1.5	3.57
Acid × sugar	1.0	2	.5	1.19
Acid × alcohol	0	1	0	
Tannin × sugar	19.0	2	9.5	22.62***
Tannin × alcohol	.2	1	.2	.48
Sugar × alcohol	2.9	2	1.45	3.45
Residual	3.8	9	.42	
Total	221.3	23		

*** Very highly significant.

ences in acid. The other interactions were found insignificant.

Since the interactions involving acidity were found not significant, the main effect of acid was tested against the pooled value of all acid interactions. The acid concentration effect was found very highly significant, as would be expected from Weber's law.

The tannin and sugar main effects were tested against the significant tannin × sugar interaction, which led to the awkward conclusion that neither tannin nor sugar concentrations were significantly responsible for changes in minimum detectable acid differences. However, from a study of the data of Table 5, tannin, in the absence of sugar, has a marked effect upon the detectable acid concentration difference. Sugar, in the absence of tannin, did not show this effect.

The significance of the results of this and two previous papers *(2, 3)* to the wine industry will be made evident in a later paper which will contain determinations of minimum difference concentrations in wine.

SUMMARY

Detectable concentration differences and threshold concentrations were determined for ethyl alcohol, glycerol, and acidity in aqueous solution. The effect of the presence of other substances on these concentration differences was studied.

Sucrose concentration increased both the threshold and detectable difference concentrations for alcohol. The alcohol concentration itself affected the detectable difference. The presence of organic acids tended to diminish the effect of sucrose on sensitivity to alcohol concentration differences.

Both alcohol and acidity increased the threshold concentration for glycerol.

The acidic threshold was increased by alcohol, but unaffected by sucrose concentration. Upon the minimum detectable concentration difference for acid, the effect of acid concentration was very highly significant. Sugar and alcohol had no effect. A significant tannin-sugar interaction was found; the presence of sugar tended to minimize the effect of tannin.

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Film Deposition of Tomato Juice on Heat Exchanger Coils[a]

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(Manuscript received March 2, 1955)

Some factors which affect film deposition of tomato juice on steam heated coils during atmospheric concentration are presented. Investigation of materials and procedures which affect film deposition included the effect of: (a) hot break temperature, (b) type of metal in the heat exchanger coils, (c) commercial and tomato enzyme systems, (d) chelating agents, (e) tomato fiber particle size, (f) varying of steam pressure in heat exchanger coils, (g) silicone film on heat exchange surface and (h) steam injection of high temperature hot broken tomato juice prior to evaporation. A method which employed a 40 psig. steam injection treatment into high temperature hot broken tomato juice just prior to evaporation prevented film deposition and did not adversely affect viscosity, anti-weeping qualities and rate of evaporation.

The tomato processing industry has long been plagued by the problem of tomato film deposition on heat exchange surfaces. This filming problem reduces plant capacity and often adversely affects product quality and storage stability. Numerous inquiries from industry have indicated a definite need for a method to prevent the "filming on" of tomato juice during evaporation. This problem is extremely serious when high temperature hot broken tomato pulp is heated or concentrated. However, low temperature hot broken tomato juice is generally concentrated without film deposition on heat exchange coils. When concentrated, this juice, which characteristically has had its pectic substances degraded, results in a product of poor yield, viscosity, and anti-weeping qualities.

Studies have been reported on the concentration of tomato juice using a low temperature, falling film evaporator *(2)*. A portion of the pulp was removed from the juice, the depulped fraction evaporated and restored to the pulp. Factors influencing the quality of tomato puree and paste have been cited in the literature *(1, 6)*. Considerable information pertaining to pectic enzymes is also found in the literature *(3, 4)*. The predominant enzymes found in tomatoes are pectin esterase, polygalacturonase, and depolymerase.

Various compounds have been applied to the heating coils to facilitate removal of the film deposit. Silicone compounds may be mentioned in this respect *(7, 8)*.

EXPERIMENTAL METHODS

A stainless steel atmospheric cooker was fabricated from a small oxygen tank and the necessary fittings attached. This tank was provided with steam and condensate lines as well as steam traps. Three sets of heating coils were constructed using copper, nickel, and stainless steel (Figures 1 and 2). All the coils had the same heating area, 0.92 sq. ft., and the same thickness of the metal wall, 0.03 in. A stainless steel sleeve was used to prevent any splashing of product during evaporation. The capacity of the evaporator was approximately 7 gallons without the sleeve inserted.

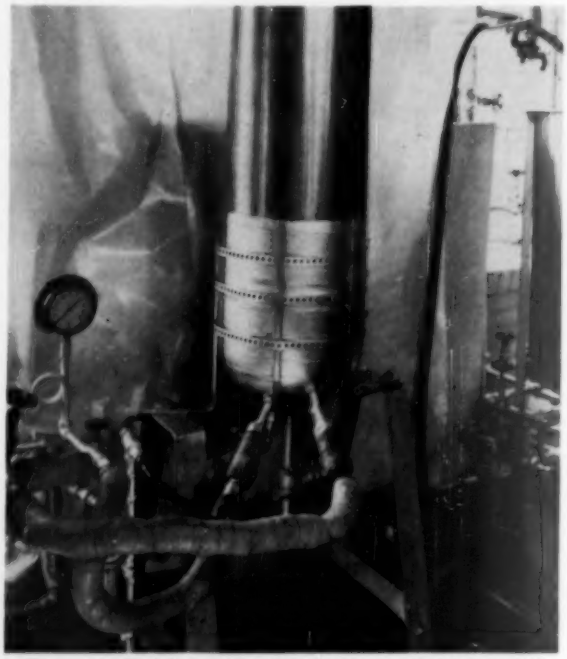

Figure 1. Stainless steel atmospheric cooker fabricated for use in film deposition studies.

Ripe tomatoes (Rutgers var.) were processed in the following manner: The tomatoes were washed in a reel washer, destemmed, trimmed, inspected, run through a chopper into a Langsenkamp atmospheric cooker (40 gal. total capacity) and hot broken at various temperatures. A preblanching operation, as described by McColloch *et al. (5)*, was carried out on certain lots of tomatoes just prior to hot breaking. This blanching treatment inactivated surface enzymes and allowed very little enzymatic activity and pectin degradation. After hot breaking, the juice was passed through a finisher equipped with an .060 in. screen, placed in 30-pound tins, frozen and stored at —40° F. When used, the tomato juice was defrosted in a steam-jacketed kettle with the temperature of the juice maintained below 65.5° C. (150° F.).

Viscosity measurements of the tomato juice were recorded from a Brookfield Synchro-lectric viscometer (multi-speed model LVF). The viscosity of the serum was determined by an Ostwald capillary viscosimeter. The procedure used for the blotter test was as follows: Five ml. of tomato product was placed on a Whatman No. 50 filter paper. After a period of one minute, the difference between the radius of the suspended solids and that of the serum was measured and expressed in units of 1/32 of an inch. Soluble solids were determined with the Abbé refractometer.

Commercial pectic enzymes were added to high hot break tomato juice to study their action on film deposition. Poly-

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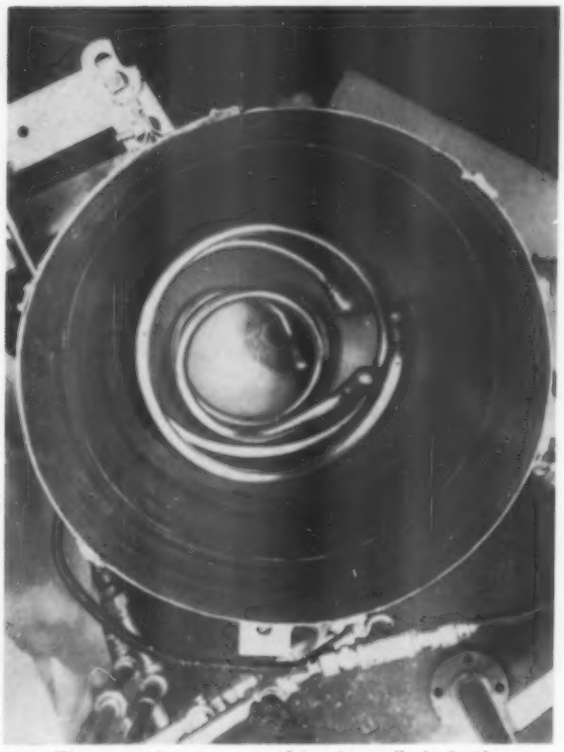

Figure 2. Arrangement of heating coils in kettle.

galacturonase (Pectinol O)[4] and pectin esterase[4] were the 2 enzymes employed in these studies. The enzyme preparations were added to the juice and allowed to stand for a definite time period at room temperature before concentration.

RESULTS AND DISCUSSION

Temperature of hot break. Both low and high hot broken tomato juices were evaporated in this study using 3 sets of coils, namely, copper, nickel and stainless steel. The results of this experiment are presented in Table 1 which shows the comparison of low and high hot broken tomato juice evaporated with different heat exchanger coils. The low hot broken tomato juice did not deposit any film on any of the coils during the evaporation. In the results using high hot broken tomato juice, film was evident on the copper and nickel surfaces, but not on the stainless steel coils. The soluble solids concentration was increased more in the copper coil tests than in the case of the other 2 coils. Viscosity measurements also followed a similar pattern. Evaporation affects the viscosity of the juice as well as its soluble solids content. When viscosity measurements of concentrated tomato pulp are examined, the soluble solids content should also be considered. The viscosity increased greatly with only a small increase in soluble solids after a solids concentration of about 15% had been reached.

No film was evident on the stainless steel coils after concentration of high hot broken tomato juice. One possible explanation for this phenomenon may be the low thermal conductivity and low coil surface temperature. It should also be noted that the rate of water evaporated per minute was highest in low hot break tomato juices and with copper coils.

Use of enzymes. Commercial pectic enzymes were used to treat high hot broken tomato juice. Only Pectinol O completely inhibited "filming on" of tomato juice. This enzyme preparation was added, at 2 concentrations, to high hot broken tomato juice and allowed to stand at room temperature for several periods of time before evaporation. Pectin esterase was also used but a film was evident on the coils after the juice was concentrated. The results using Pectinol O with high hot broken tomato juice are shown in Table 2.

When a concentration of 0.5% Pectinol O was used, less than 15 minutes standing did not cause sufficient pectin degradation to inhibit film deposition. With 0.1% Pectinol O, 2 hours seemed to be the minimum time necessary for enzymatic action in order to prevent film deposition. By using Pectinol O for the enzymatic degradation of pectin, a concentrated product was obtained without film deposition on the heat exchanger coils. However, this treatment offers no practical answer to the problem since some pectin is degraded, viscosity is reduced, and the anti-weeping qualities are inferior to those of the regular high hot broken product.

Since the commercial enzyme, Pectinol O, prevented film deposition, an experiment was carried out using raw juice as enzyme source. This material was not heat treated and the natural enzyme system was active. Fifty percent by weight of raw juice was added to blanched high hot broken juice and allowed to stand 1 hour at room temperatu This juice was then evaporated in the pilot cooker for 6 minutes. The evaporation rate was good and only a slight film developed on the coils. The concentrate exhibited poor anti-weeping and viscosity characteristics. This indicated degradation of the pectic substances. This experiment was repeated with similar results.

Tomato pulp contains about 1% protein. Proteolytic enzymes, pancreatin and pepsin, were added to high temperature hot broken juice. These proteolytic enzymes did not produce any noticeable effect on film deposition.

Industry has long suspected the relationship found here between pectin degradation and filming tendency of the juice. It is evident that pectin esterase is not the only enzyme present in raw juice which may act to prevent filming. These results justify the industry practice which utilizes a hot break temperature that allows some enzymatic degradation of pectic substances in the tomato juice. Such a practice, although not completely satisfactory from the standpoint of viscosity and anti-weeping qualities of the product, reduces the problem of film deposition so that it can be handled under commercial processing conditions.

Chelating agents. Qualitative tests of the film recovered from the heat exchange coils indicated the presence of some pectic compounds. In the event calcium pectate was the predominant compound in this film, experiments were conducted to show the effect of tying up of the calcium ions. Chelating agents were used to observe their effect on film deposition tendencies in high temperature hot broken tomato juice. Versene; Sequestrene, Calgon and phytic acid were used in this study.

The results indicate that the chelating agents reduced film deposition to a limited degree. The use of chelating agents would present legal problems. Since they did not offer a satisfactory control for film deposition, no further work was done.

Effect of particle size. Low and high hot broken tomato juice was passed through a finisher equipped with various screen sizes and then evaporated for definite time periods. The results

[4] Rohm and Haas Company, Philadelphia, Pennsylvania.

TABLE 1

Evaporation of low and high hot break tomato juice

Run	Degree hot break	Lb./min. evap.	Min. evap.	% Soluble solids	Viscosity (centipoise)	Degree of film
Copper coils						
1A	140	0	0	5.2	1,000	
1B	140	3.7	6	19.5	100,000	none
2A	210	0	0	6.0	3,200	
2B	210	2.6	6	14.0	25,500	v. heavy
Nickel coils						
1A	140	0	0	5.0	800	
1B	140	4.12	6	10.5	18,500	none
2A	210	0	0	4.7	1,980	
2B	210	3.12	6	8.5	18,000	heavy
Stainless steel coils						
1A	140	0	0	4.8	800	
1B	140	2.04	6	6.7	1,800	none
2A	210	0	0	4.6	1,840	
2B	210	2.0	6	6.5	6,000	none

particle size slightly increased the evaporation rate in both low and high hot broken samples. However, film deposition was not significantly affected and results were as expected for low and high hot broken tomato pulp.

It was thought that the physical shearing and drastic reduction of the particles might break up the pectin molecule sufficiently to decrease film deposition. Lots of high hot broken tomato juice were passed through a colloid mill, a homogenizer, or a combination of both. These treatments did not reduce the tendency for film deposition. The opposite effect was created and even more film was deposited on the coils. This may be caused by the greater particle surface that is exposed to the coils or the release of a greater amount of pectin from the tomato fiber.

Effect of varying steam pressure in the heating coils. Data presented in the previous experiments were based on the use of 100 p.s.i.g. steam pressure in the heating coils. The effect of the use of lower steam pressures in the copper heating coils on the filming tendency of high hot broken tomato juice is presented in Table 4.

No film was deposited on the coils until a steam pressure of 50 p.s.i.g. was used. Heat transfer was substantially reduced at the decreased coil pressures and the evaporation rate was low. The results of this study indicate that heating-coil temperatures, above a certain critical level, promote film deposition. Apparently the heating-coil temperature is a more important factor in film deposition than is the turbulence of the boiling juice. This statement seems justified since the turbulence of the boiling juice was significantly increased in each run in which the steam pressure in the coils was raised (Table 4). Reducing steam pressure in the copper coils, to below 50 p.s.i.g. rather than the 100 p.s.i.g. commonly used, controlled film deposition in the pilot cooker. However, such a practice offers no practical solution for the problem since the evaporation rate is materially reduced.

Silicone compounds. Several lots of low and high hot broken tomato juice were concentrated using copper heat exchange coils which were covered with a thin film of silicone grease. Tomato film was easily removed from the silicone treated coils. However, the rate of evaporation with high temperature hot broken tomato juice was about 50% of that found with the steam injection treatment.

Effect of steam injection. The treatment of high hot broken tomato juice which allowed a precook for a period of 4 minutes was tested. With this treatment, the coils were cleaned after the pre-cook, the product was returned to the kettle and the final evaporation was accomplished without coil fouling. This showed that the film deposition took place very early in the concentration process. If filming did not take place, or if the coils were cleaned and the product returned, the tomato concentrate could be boiled for 20 minutes without film being deposited on the heat exchange surfaces. This finding led to the belief that temperature was possibly a significant factor in preventing film deposition. Therefore, a method was devised to heat tomato juice without coils to various temperatures prior to evaporation.

An open steam line was installed in the base of a pressure cooker equipped with a slow revolving agitator. Blanched high hot broken tomato juice was placed in this pressure cooker and the top clamped on securely. The pressure and temperature inside the chamber were increased by direct steam injection to a given value and held for one minute. The juice was then placed in the pilot model cooker and evaporated for 5 minutes. The effect of direct steam injection in high hot broken tomato juice prior to evaporation is shown in Table 5.

Treatments using higher steam pressures generally resulted in products which showed increased rates of water removal dur-

TABLE 2

Effect of pectinol O on high hot break tomato juice

Run	Evap. rate lb./min.	Min. evap.	Blotter test (in 32nds inch)			% Soluble solids		Time at room temp. (in hours before evap.)	Degree of film
			Before enzyme treatment	After enzyme treatment	After evaporation	Before evap.	After evap.		
0.5% Pectinol O									
1	3.2	6	10	33	14	5.2	20.0	4	none
2[1]		15	10	34	20	5.4	10.0	3.5	none
3	3.7	6	13	34	28	6.0	10.0	1	none
4	3.4	6	12	38	15	6.8	9.4	0.5	none
5	2.8	6	16	24	12	6.2	16.1	0.25	none
6	2.8	6	14	42	12	6.5	17.5	0.16	some
7	2.6	6	15	42	11	6.0	17.8	0.08	some
0.1% Pectinol O									
1	3.5	6	16	44	14	5.5	9.5	3	none
2	3.5	6	12	28	18	6.4	11.2	2	v. slight
3	3.1	6	14	24	12	6.4	10.3	1	heavy
4	3.1	6	10	32	9	6.2	9.4	0.25	heavy
No Enymatic Treatment									
1	2.9	6	7		6	6.4	9.0		heavy

[1] Water addition necessary in order to evaporate for 15 minutes.

TABLE 3

Effect of particle size of tomato juice solids on evaporation characteristics

Run	Degree hot break	Finisher screen size (inch)	% Soluble solids	Minute evap.	Viscosity (centipoise)		Lb./min. evap.
					Serum	Juice	
1A	140	0.060	5.2	0	1.51	1,060	
1B	140	0.060	19.5	6	2.65	71,000	3.66
2A	140	0.031	6.0	0	1.46	6,600	
2B	140	0.031	14.4	4	2.15	55,000	3.6
3A	140	0.027	6.5	0	1.21	1,080	
3B	140	0.027	16.4	4	1.72	17,500	3.4
4A	210	0.060	5.4	0	4.29	3,080	
4B	210	0.060	12.8	6	13.7	43,500	2.42
5A	210	0.031	6.0	0	4.25	9,800	
5B	210	0.031	12.5	4	12.2	33,000	2.4
6A	210	0.027	6.5	0	3.16	2,280	
6B	210	0.027	13.7	4	4.75		3.0

TABLE 4

Effect of steam pressure in the copper heating coils on film deposition of high hot break tomato juice

Run	Steam pressure p.s.i.g.	Lb./min. evap.	Viscosity (centipoise)	% Soluble solids	U BTU/hr. (ft.²) (° F.) cond.	Min. evap.	Degree of film
1A			2,580	6.6		0	
1B	7.5	0.33	3,000	6.7	168	6	none
2B	30	1.6	3,500	9.0	720	6	none
3A				6.5		0	
3B	40	1.7	9,000	10.6	871	6	none
4B	50	2.1	10,400	11.7	1,060	6	heavy

TABLE 5

Effect of steam injection on the filming properties of high hot break tomato juice concentrated for 5 minutes in a cooker equipped with copper coils

Run	Steam pressure in cooker p.s.i.g.	% Soluble solids	Initial weight lb.	Final weight lb.	Lb./min. evap.	Degree of film	Blotter test 32nds inch	Viscosity (centipoise)
1 Tomato juice before treatment	0	6.4					6	19,000
2	15		26.0	11.0	3.0	heavy		
3	25		27.0	11.0	3.2	some		
4	30	15.5	29.5	11.0	3.7		2	38,500
5	35	17.0	29.0	10.0	3.8	some	2	50,000
6	40	17.0	29.0	9.0	4.0	none	4	67,000
7	40		28.0	11.0	3.4	none		
8	50	17.0	31.0	10.5	4.1	none	3	31,000
9	50		27.0	9.5	3.5	none		

ing concentration. In runs 5, 6, 7 and 8, no film was evident on the coils when a pressure of 40 p.s.i.g. or more was used in the pressure cooker. The evaporation rate was good and the viscosity of the final product was high. The blotter test revealed that little syneresis of the product occurred after evaporation. There was no evidence of any film deposition in the pressure cooker after the steam injection treatment. The materials which cause film deposition of high temperature hot broken tomato juice on the copper heat exchanger coils were stabilized by this treatment. This procedure, under the conditions and equipment used in this experiment, definitely prevented any film deposition on the heat exchange surface. The concentrated product was characterized by viscosity and anti-weeping qualities which closely resembled conventionally concentrated high temperature hot broken pulp.

SUMMARY AND CONCLUSIONS

Low temperature hot broken tomato juice (140° F.), which characteristically has had its pectic substances degraded, is generally concentrated without film deposition on heat exchanger coils. High temperature hot broken tomato juice (210° F.), in which the pectic substances are preserved, deposits a heavy film on the heat exchange surfaces during evaporation. Film deposition was found when high hot broken tomato juice was concentrated with copper and nickel coils but not when stainless steel coils were used. However, the rate of evaporation was extremely low when stainless steel heat exchange coils were used.

The addition of several enzyme systems, including commercial and tomato enzymes, to high hot broken tomato juice prevented or reduced film deposition. However, the pectic substances were degraded and the viscosity and anti-weeping qualities of the concentrate were similar to those of low hot broken tomato pulp.

Several chelating agents reduced film deposition slightly. Reduction of particle size, in tomato pulp, did not materially affect film deposition and low and high hot broken tomato juice showed usual filming tendencies. Drastic tomato particle reduction, by means of homogenization and the colloid mill, increased the filming problem in high temperature hot broken juice. If steam pressure, in the copper heating coils, was reduced to 40 p.s.i.g. no film was deposited when high hot broken tomato juice was concentrated. However, the rate of evaporation was quite low.

Coating of the copper coils with a film of silicone grease materially aided in film deposition removal but substantially decreased the rate of evaporation.

A pre-evaporation treatment, steam injection at 40 p.s.i.g, prevented film deposition in high temperature hot broken juice. The tomato concentrate was characterized by excellent viscosity and anti-weeping qualities. The rate of evaporation, from steam injected high temperature hot broken juice, was comparable to that generally obtained with low temperature hot broken tomato pulp.

Under the conditions and equipment used in this study, the steam injection treatment showed great promise. However, before commercial application is justified, further runs should be made on a factory basis.

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Effect of Certain Holding Conditions on Shelf-Life of Fresh Poultry Meat[a]

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The shelf-life and weight change characteristics of fresh poultry meat stored in crushed ice and at 31° F. and 38° F. were studied. Both packaged and unpackaged birds were used in order to evaluate different packaging media for protective qualities as well as their influence on "shrink."

Today's trend toward self-service meat marketing emphasizes the importance of proper holding conditions for fresh poultry meat. In the poultry industry this trend is toward a pre-packaged pan-ready product. Due to the economics of mass production more and more poultry is being prepared in the pan-ready form at the processing plant.

The purposes of this study were (a) to compare the shelf-life and weight change characteristics of fresh poultry meat stored in crushed ice, both packaged and unpackaged; (b) to evaluate the difference in shelf-life and weight change of birds stored at temperatures of 31° F. (—0.6° C.) and 38° F. (3.3° C.); and (c) to evaluate the effect of holding fresh poultry meat in different packaging materials as well as to determine the "shrink" or weight change characteristics in these different packaging media.

Ogilvy and Ayres *(10)* reported the bacteria responsible for the deterioration of cut-up chicken held at refrigerator temperatures above freezing to be closely related types of *Pseudomonas* and *Alcaligenes*. Gunderson, Rose and Henn *(3)* and Lockhead and Landerkin *(8)* reported similar findings. Temperature of storage appears to have a marked influence on the predominant flora found present during spoilage, and Ayres *(1)* reported that at temperatures of 32° F. (0° C.) and even 40° F. (4.4° C.) many mesophilic organisms do not multiply.

Kraft and Ayres *(7)*, while studying the effect of packaging materials on the keeping quality of self-service meats, found that where wraps permitting appreciable amounts of moisture loss were used as packaging materials desiccation did not proceeed to the extent that levels of humidity inhibitory to bacterial growth were obtained. On the contrary, proliferation of microorganisms was most rapid with films that were ineffective as moisture barriers. These materials promoted aerobic conditions favorable for growth of surface microorganisms. Other factors that might be considered from a practical standpoint are those affecting the general appearance of the carcass, particularly the discoloration due to desiccation and to the effect of the concentration of certain gases in the surrounding atmosphere *(6, 10)*. Discoloration due to the action of gases *(10, 11)* is not so serious a problem in poultry meat as in red meat.

Kraft and Ayres *(7)* state that color changes of meat, loss of moisture, and surface bacterial growth are factors involved in spoilage and depend to some extent on the properties of the packaging material. This report was confirmed as applying to poultry meat by Stewart *(11)*. Kish *(6)* reported a study of four different packaging films in which he found no significant difference in spoilage or weight change due to packaging treatments. Kraft and Ayres *(7)*, reporting results of testing ten different wrapping materials as to their effect on the keeping qualities of self-service meats, found that cellophane film permitted the greatest weight losses with fresh packaged beef and that the weight losses observed in the other films were negligible.

Few publications on ice storage and its effect on the quality of poultry meat were noted in the literature. Newell, Gwin and Jull *(9)* reported that unpackaged birds held in ice displays maintained their fresh-killed appearance until spoilage, while others held in dry refrigeration developed red areas indicative of dehydration. Gwin *(4)* found that the rate of water absorption for birds held in crushed ice depends upon the dressing temperature, method of cooling, and the extent of flesh exposed.

EXPERIMENTAL PROCEDURE

The experiment consisted of 4 replicates conducted at different times. Twenty-four fryer halves were used in each of the first 2 replicates and 48 halves in each of the last 2 replicates. The birds used in this study were 9 to 11-week-old chicken fryers. All birds used in each replicate were of the same age, similar genetically, grown under the same conditions of environment and nutrition, held without feed for the same period of time prior to slaughter, processed in the same manner, and subjected to the same handling treatment prior to packaging and storage. All birds were processed at the College plant. They were dispatched by severing both jugular veins and were permitted to bleed thoroughly prior to scalding. After bleeding, the birds were given a 35-second scald at 140° F. (60° C.) in a rotating scalder, rough picked on a single drum picker, and hand finished. Following picking, each bird was thoroughly washed with running cold water and placed in an ice water cooling tank for 2 hours. After chilling, the birds were eviscerated by cutting through the ribs along each side of the backbone, making the incision completely around the vent and removing the neck, backbone, and viscera intact. The kidneys and lungs were then removed. The neck, backbone, and giblets were not packaged.

Following washing, the birds were tagged (to maintain the identity of individual birds) and cut into halves. The halves were then hung in a refrigerated chill room maintained at 33° F. (0.6° C.) with a unit type evaporator, in order that each half would have an equivalent amount of surface moisture when packaged.

In each of the first 2 replicates the 24 halves were divided into two equal groups. In the first group the 12 halves of 6 individual birds were packaged in absorbent pulp trays with blotting paper backboards using a Sylvania 300-MSBO cellophane over-

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wrap, and heat sealed. Six of these halves were stored at 38° F. (3.3° C.) and the corresponding 6 halves at 31° F. (—0.6° C.). In the second group the 12 halves of 6 individual birds were packaged in Shelmar 1.5 mil. polyethylene bags and sealed using metal bag closure clamps. Six of these halves were stored in 38° F. (3.3° C.) and the corresponding 6 halves at 31° F. (—0.6° C.).

Observations were made for general appearance, slime, and off-odor. General appearance and organoleptic odor observations were made by a five-member panel of observers. Slime observations were conducted at the same time, using the method of Ziegler, Spencer and Stadelman *(12)*.

Judging was conducted in the same room and under the same lighting and ventilating conditions for each observation. A numerical scoring of 1 to 5 was used for general appearance evaluation; 5 being excellent condition and 1 being undesirable or unsalable condition. Odor was scored on the basis of either a positive or negative observation. Birds were considered positive if off-odor condition was detectable. A treatment group composed of 12 halves of 6 individual birds packaged in absorbent pulp trays with blotting paper backboards using a Shellmar 1.5 mil. polyethylene bag overwrap and sealed with metal bag closures and stored at 31° F. (—0.6° C.) or 38° F. (3.3° C.) was added to the third and fourth replicates. The third and fourth replicates were further modified to include a group composed of the 12 halves of 6 individual birds packed in crushed ice with six halves packaged in Sylvania 300-MSBO cellophane bags and 6 halves unpackaged. These birds were stored in household ice-cooled refrigerators without forced air circulation. Another addition included in the third and fourth replicates was the collection of weight change data. Weights of all bird halves and the weight of each package were recorded at the time of packaging and at the time of spoilage.

RESULTS AND DISCUSSION

On the basis of off-odor determinations, birds stored in mechanical refrigerators at 38° F. (3.3° C.) and packaged in absorbent pulp trays with an overwrap of cellophane, had an average shelf-life of 10.7 days. This is an average of 24 fryer halves in 4 replications. The corresponding halves of these same birds had a shelf-life of 18.7 days when stored under similar conditions but held at 31° F. (—0.6° C.). The same number of birds, handled in the same manner but packaged in polyethylene bags, were found to have a shelf-life at 38° F. (3.3° C.) of 10 days and at 31° F. (—0.6° C.),17.8 days.

There was no significant difference in the number of days to spoilage between the cellophane and polyethylene packages described above. There was a highly significant difference between the two temperatures tested, since the additional days to spoilage with 31° F. (—0.6° C.) for the cellophane and polyethylene groups were 8.0 and 7.8, respectively, when compared with results using the higher temperature.

These results are in agreement with the findings of Kish *(6)* who compared the shelf-life of fryers packaged in similar cellophane (LSAT) with fryers packaged in polyethylene (1 mil.) film and found no significant difference. The additional number of days for spoilage to occur at the lower storage temperature agrees with the findings of Ayres, Ogilvy and Stewart *(2)*. They found that cut-up fryers stored at 40° F. (4.4° C.) kept from 6 to 8 days and those stored at 32° F. (0° C.) kept from 15 to 18 days.

Results of odor basis comparisons between paired halves of packaged (300-MSBO cellophane bags) and unpackaged birds stored in crushed ice and held in ice-cooled refrigerators show that the number of days to spoilage for the packaged birds was 18.4 while that for the unpackaged birds was 17.5 days. There was a significant difference ($P<0.05$) in favor of packaged birds.

Analysis of the slime data for the cellophane and the two polyethylene treatments gave results that were essentially the same as were found for the same comparisons on an odor basis.

Although there was no significant difference between the packaging treatments studied on the basis of slime and odor observations, there were pronounced differences when the general appearance of the birds was used as the criterion for evaluation. It is believed that one of the reasons for greater differences than have been previously reported in the literature is related to scald temperature. Birds scalded at 140° F. (60° C.) lose the greater part of the epidermal layer of skin during the picking process. On the other hand, birds scalded at 130° F. (54.5° C.) lose very little of this epidermal layer. Loss of "bloom" for birds scalded at 140° F. (60° C.) appears to make them more subject to desiccation and its subsequent discoloration. All birds used in this study were processed using 140° F. (60° C.) scald water, whereas the birds used in the studies cited in the literature as reporting on carcass appearance were scalded at 130° F. (54.5° C.) or less.

The average general appearane score at spoilage for all birds in each treatment group stored at 38° F. (3.3° C.) followed the same pattern as the average values shown in Table 1 for the 14th day of storage at 31° F. (—0.6° C.). The 14th day of storage was selected for these comparisons because it characterizes the condition of the birds just prior to spoilage in any treatment group, being the first day of slime detection and 2 days prior to odor detection.

Table 1 contains the general appearance scores taken from the third and fourth replicates in order that ice storage comparisons might be included. The 31° F. (—0.6° C.) group was selected for this comparison as it approximates the mean temperature for ice-stored birds. Temperatures recorded for ice-packed birds ranged between 29.5° F. (—1.4° C.) and 32° F. (0° C.). This agrees with the temperature Newell, Gwin and Jull *(9)* and Gwin *(4)* reported for birds stored in crushed ice. They report that prior to use for packing birds the ice was stored at less than 20° F. (—6.7° C.), thus accounting for the lower temperature. Prior to use, the ice for this study was stored at —10° F. (—23.3° C.).

In later studies using more accurate temperature measuring devices a temperature difference of about

TABLE 1

General appearance scores[1] for 14th day of storage at 31° F. (—0.6° C.) or ice packed

Packaging	Rep. III	Rep. IV
Cellophane [2]	1.7	2.4
Polyethylene [3]	3.0	2.9
Polyethylene [4]	3.1	3.3
Ice [5]	1.7	1.3
Ice [6]	2.8	2.7

[1] Perfect score = 5.
[2] Birds packaged in absorbent pulp tray using 300-MSBO cellophane overwrap.
[3] Birds packaged in polyethylene bags.
[4] Birds packaged in absorbent pulp tray using polyethylene bag overwrap.
[5] Birds stored in crushed ice without packaging.
[6] Birds stored in crushed ice packaged in 300-MSBO cellophane bags.

1° F. (0.6° C.) was found between paired halves of broilers held in melting ice without packaging and those packaged in polyethylene bags submerged in another container of the same melting ice. Therefore, it appears that at least part of the temperature decrease below 32° F. (0° C.) is due to soluble solids from the unpackaged meat depressing the melting point of the ice below 32° F. (0° C.).

Analysis of the general appearance data summarized in Table 1 indicates a significant difference between treatments ($P<0.05$). Comparison of average general appearance scores (see Table 1) for the treatment groups indicated that the differences among the various packaging treatments were all highly significant except for the differences between polyethylene bag and polyethylene bag with absorbent tray, and between polyethylene bag and ice storage in cellophane bag. Packaging materials can be ranked as to acceptability on the basis of data in Table 1 as follows: (a) polyethylene with absorbent tray, (b) polyethylene bag, (c) ice storage in cellophane bag, (d) cellophane with absorbent tray, (e) ice storage unpackaged.

Under the conditions of this experiment it was found that birds packaged in cellophane and stored in mechanical refrigerators developed discolored patches wherever the film was in contact with the skin. There was further evidence of desiccation in the discoloration and shriveling observed about the hocks and wing tips of birds packaged in this manner and stored at either temperature. Birds packaged in polyethylene, with or without the absorbent pulp tray, maintained an attractive appearance until spoilage. Unpackaged birds, stored in crushed ice, developed a pale white appearance, apparently caused by the leaching action of the melting ice. Toward the end of the storage period there was evidence of tissue degeneration on the cut surfaces. This may have been caused by the action of native proteases as suggested by Hepburn *(5)* or possibly due to the increased bacterial activity on the cut surfaces of poultry meat reported by Ayres, Ogilvy and Stewart *(2)*. The loss of color manifest in unpackaged birds stored in crushed ice was overcome by packaging in cellophane; this resulted in a more attractive bird than one packaged in cellophane and stored in mechanical refrigeration.

Mean percentages of weight loss based on the carcass weight at time of packaging were as follows: (a) 8.3% for cellophane with absorbent tray, (b) 5.5% for polyethylene with absorbent tray, (c) 1.4% for polyethylene bag. These percentages appear to be a reflection of the moisture-vapor permeability of the films used and the effect of the absorbent pulp tray. The MSBO cellophane used in this study possesses a higher moisture-vapor permeability than the polyethylene film. It is moisture-proof coated on one side only and was designed to permit the product so wrapped to "breathe." The increased rate of moisture loss for birds packaged in polyethylene with absorbent pulp tray and blotting paper backboard as compared with those packaged in polyethylene alone must be attributed to the absorbing action of the tray and blotting paper backboard, for the addition of the tray and backboard was the only difference between the two treatments. There was an average of 1.3% greater weight loss at 38° F. (3.3° C.) for birds packaged in cellophane and polyethylene (both with absorbent pulp trays) as compared with similarly treated birds stored at 31° F. (—0.6° C.). Birds packaged in polyethylene bags (without absorbent pulp trays) had essentially the same loss at both temperatures.

SUMMARY AND CONCLUSIONS

Shelf-life of chicken fryers was studied for birds stored in crushed ice, and birds stored at 38° F. (3.3° C.) and 31° F. (—0.6° C.) in mechanical refrigerators. Birds were studied in five packaging treatments.

On the basis of slime and odor observations, there was no significant difference between packaging treatment groups. Good agreement was found between slime smears and sensory panel observation as methods of determining spoilage. Shelf-life for birds in all treatment groups held in mechanical refrigerators was extended approximately 8 days when stored at 31° F. (—0.6° C.) as compared to 38° F. (3.3° C.).

On the basis of general appearance scorings, the packaging materials can be ranked for acceptability as follows: (a) polyethylene with absorbent tray, (b) polyethylene bag, (c) cellophane bag, stored in crushed ice, (d) cellophane with absorbent tray, (e) unpackaged, stored in crushed ice. There was no significant difference between the two polyethylene treatment groups.

On the basis of weight changes observed, polyethylene bag packaging appeared to be the most desirable for birds stored in mechanical refrigerators.

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Producing Florida Citrus for Frozen Concentrate[a,b]

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Production of Florida citrus fruit for the past two years has exceeded 100 million boxes and represents more than two-thirds of the total United States citrus production. More than half of this fruit was processed. An adjunct of the increased production and consumption of Florida citrus frozen concentrate has been the development of cultural programs designed to produce fruit of high juice quality. An increasing number of processors are willing to pay for fruit according to its soluble solids and juice content, because high solids fruit results in increased plant capacity, reduced production costs and increased quality of the finished product. The grower, consequently, must adopt practices known to produce high internal quality fruit and discard those which adversely affect it.

Vigorously growing stocks, such as rough lemon, produce more fruit but with a lower soluble solids content than slower growing stocks such as sour orange. Deficiencies of nutrient elements such as magnesium, zinc, manganese, iron and copper reduce the soluble solids, acid and vitamin C content of the fruit, whereas excessive applications of potash also reduce the soluble solids content. The latter may result directly or indirectly through the production of larger sized fruit.

Excessive or poorly timed irrigation and improper timing of oil sprays result in reducing the soluble solids content of the fruit and dollar returns to the grower.

Florida's citrus production during the 1952-53 season was 109,920,000 boxes. Of this total, 72,000,000 boxes of oranges, 32,500,000 boxes of grapefruit, and 4,900,000 boxes of tangerines were produced. These oranges, grapefruits, and tangerines—laid side by side—would extend around the world at the equatorial axis as a continuous band approximately ten feet wide. Estimated production for the 1953-54 season is in excess of 125,000,000 boxes or approximately a 13% increase over the record-breaking crop of last year. The present satisfactory production situation in Florida was not easily accomplished; neither is it a simple reflection of acreage correlated with yield. In 1952-53, Florida's 468,700 acres of producing groves yielded 62.8% of the citrus produced in the United States on only 59% of the total United States acreage *(12)*. Most of this fruit is produced on soils low in natural fertility, and production practices now in use have evolved largely from research born of absolute necessity.

An adjunct of the increasing production of Florida citrus has been the difficult problem of marketing this volume of fruit at such prices that growers, packers, and processors may be reasonably well paid for their efforts. The development of frozen citrus concentrate and its favorable public acceptance has been a boon to the entire industry. The production of 46,554,000 gallons of orange concentrate during the 1952-53 season and the consequent utilization of 32,646,000 boxes of fruit means that approximately 45% of the Florida orange crop last year was diverted into this marketing channel. Changes not only in the marketing of Florida fruit but also in production practices have resulted.

Federal grades for fruit are based largely on the external appearance of the fruit. From its beginning, the Florida production program has been based on producing fruit of good color, clean, bright, and free from blemishes—which is not easy in the humid climate of Florida. Little attention had been given to internal quality, provided it would pass minimum maturity standards enacted by the State Legislature to insure fruit of acceptable internal quality going to market. Previous to the development of frozen concentrate processing, however, there was no incentive which would induce growers to produce fruit of better internal quality than the maturity standard required.

Producers of frozen orange concentrate, once the growing pains of putting new plants into operation were behind them, were quick to realize the advantage of high internal quality fruit for their operation. Not only was the quality of their product improved but the efficiency of their plant operation was also affected. Since it requires less time, steam, and man hours to prepare 42° Brix concentrate from fruit with an initial Brix reading of 12 than is required for fruit with a 10° Brix value, buying higher quality fruit was in effect a means of increasing the efficiency and capacity of the plants. Since the production of concentrate from high quality fruit costs less, this fruit is in reality worth more, and as a result a procedure for buying fruit on the basis of its juice and soluble solids content has evolved. Not all processing plants have accepted this idea as yet, but its adoption is becoming widespread, and with it the Florida grower is developing a much keener interest in internal quality and the various factors which affect quality in citrus fruit. This discussion is directed toward the magnitude of differences among the salient factors and a comparison of their possible dollar values. Obviously only certain factors can be discussed and these not in detail; but it is hoped to convey a general impression of their scope and importance.

[a] Presented at the Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California, July 1, 1954.

[b] Florida Agricultural Experiment Station Journal Series, No. 284.

EFFECT ON QUALITY OF VARIETAL DIFFERENCES AND OF ROOTSTOCKS

Rather wide differences in juice quality may be accounted for solely as varietal differences. Adequate comparison may be made only where rootstock, soil, fertilization, weather conditions and other factors are comparable. Table 1 presents a simple comparison of the 3 major orange varieties grown in Florida when fruit was grown under comparable conditions and harvested at approximate peak of quality. The Hamlin orange, although frequently considered an inferior orange, ranks high as a source of vitamin C. A comparison of the yield and possible gross return per acre for the 3 varieties is shown in Table 2. The yields during the 1951-52 and 1952-53 seasons were the highest obtained for all 3 varieties during their entire history (trees are approximately 15 years old). Although the internal quality of the Hamlin orange is inferior to Valencia and Pineapple, the possible return per acre may be greater due to the greater yield. When growing fruit for the concentrate market, one of the growers' primary objectives is to produce the highest possible pounds of soluble solids per acre.

A comparison of the effects of rootstock on fruit quality has recently been published by Cook *et al. (3)*. Due to susceptibility to tristeza, foot rot *(Phytophthora parasitica* or *P. citrophthora)* and other diseases, the choice of rootstocks is fairly well limited by the soil conditions of the particular grove. Rough lemon rootstock results in a high yield of fair quality fruit at an early age. It is so well adapted to the light sandy soils of Florida that growers in these areas have little choice until some other stock equally adaptable to these soils is found which may result in the production of fruit of higher quality. On the coastal areas, where soil drainage is often poor, sour orange stock has been used for many years. Trees budded on this stock are usually less productive but produce high quality fruit. The susceptibility of sour-orange budded trees to tristeza makes its continued use as a rootstock hazardous, and Cleopatra mandarin is now being considered for use to a greater extent. Although the rootstock affects markedly the quality of fruit produced, the choice is to a certain extent fixed by conditions beyond the grower's control.

FERTILIZATION

From a rather modest beginning in citrus production where plantings were limited to the better, more fertile soils, Florida growers expanded their plantings with the introduction of rough lemon rootstock to the higher, light, sandy soils, only to find their efforts thwarted by deficiencies *(2)*. While producing a crop, many of the leaves would turn yellow and fall from the trees, the twigs would die back, and the following year little or no fruit would be produced. These symptoms of trace-element deficiencies are now easily identified and readily corrected. To circumvent perpetual recurrence of these troubles and to eliminate alternate bearing resulting from deficiencies, these essential elements are now included in the fertilizer mixture in varying amounts sufficient to supply the requirements of the trees *(8)*.

Most pronounced differences in fruit quality and yield as affected by fertilization practices occur when acute deficiencies of nutritional elements are present. This is illustrated by the production record of 2 grapefruit plots Figure 1 *(1)*. Both plots received only nitrogen, phosphorus, and potassium until 1937, at which time to one plot, magnesium, manganese, copper and zinc were supplied; the other was left on the old N-P-K program. Because of deficiencies, production by trees in the latter plot has remained at a very low level.

Table 3 presents data of a single season for comparison showing the effects on juice characteristics of oranges where magnesium, manganese, copper and zinc are supplied and where nitrogen and phosphoric acid is supplied in varying amounts. Deficiencies of supplemental elements result in decreased production and poor quality fruit *(4)*. Variations in the nitrogen supply although affecting the yield, have only a limited effect on fruit quality *(9)*, while heavy applications of phosphate appear to reduce the soluble solids, acid, and vitamin C content of the fruit *(5-11)*.

Potassium may markedly affect juice quality. One of the principal effects comes about indirectly, resulting from the influence of the potash supply on the size of fruit produced *(10, 13)*. Fruit size tends to increase as the potash supply is increased within a reasonable range. Correspondingly, as the fruit size increases, the juice constituents tend to decrease. This is illustrated in Table 4 by analyses of Valencia oranges which had received varying amounts of potash. Where sized fruits (size 216) were analyzed, the principal effect is between the zero potash treatments and where potash was supplied, irrespective of the amount. Where no potash was supplied the soluble solids, acid and vitamin C content was reduced. Analyses of randomly collected fruit, however, illustrates the reduction in soluble solids which occurred as the potash supply was increased. This effect appears to be due to the effect of potash on fruit size.

TABLE 2

Comparative approximate gross value of fruit of three orange varieties grown under comparable cultural conditions

Variety and picking date	Ave. box yield per tree[1]		Gross per acre dollar value[2]	
	1951-52	1952-53	1951-52	1952-53
Hamlin (Jan. 15, 1952, Jan. 13, 1953)	8.46	7.15	592.20	420.70
Pineapple (Jan. 31, 1952, Jan. 13, 1953)	6.01	4.53	366.10	294.70
Valencia (May 27, 1952, June 11, 1953)	5.81	3.87	469.70	322.70

[1] Box yields based on the Florida 90 pound field box.

[2] Based on analyses of fruit at harvest time and calculated on the basis of 12° Brix fruit with 5.5 gals. juice yield per box valued at $1.00.

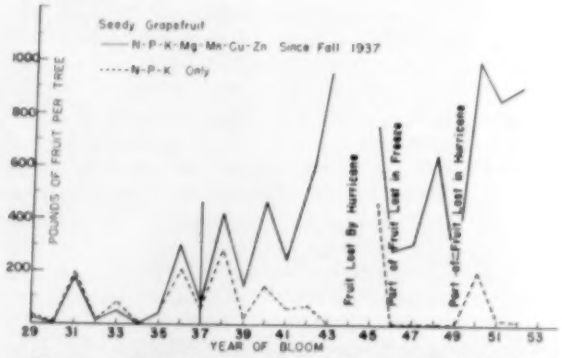

Figure 1. Production record of seedy grapefruit trees having received the same fertilizer treatment (N-P-K) until 1937. At this time the treatment for one set of trees was changed to include magnesium, manganese, copper and zinc in addition to the N-P-K treatment. The increased production following the correction of deficiencies is indicative of the response obtained in commercial groves.

TABLE 1

Comparison of three of the major orange varieties at optimum periods of juice quality. Trees were grown on rough lemon rootstock under comparable cultural conditions

Variety	Size	Juice by weight %	Soluble solids %	Titratable acid %	Ratio solids/acid	Vit. C mg./100 ml. juice	Approx.[1] value per box
Hamlin (Dec. 22, 1952)	(216)	47.04	11.68	0.92	12.65	65.7	0.87
Pineapple (Jan. 13, 1953)	(216)	45.24	12.70	1.13	11.28	68.1	0.95
Valencia (May 22, 1953)	(200)	52.97	12.32	0.87	14.16	45.2	1.14

[1] Based on fruit of 12° Brix with 5.5 gal. juice yield per box valued at $1.00.

TABLE 3

Effect of varying amounts of nutrient elements supplied in the fertilizer mixture upon juice characteristics of fruit produced

Treatments	Juice by weight %	Soluble solids %	Titratable acid %	Ratio solids/acid	Vit. C mg./100 ml. juice	Approx. value per box[1]
	Pineapple Oranges					
"Supplemental elements"						
4-6-8 (40% organic)	49.63	9.22	0.94	9.96	56.3	0.77
4-6-8-3-1-½ (40% organic)[2]	49.76	10.70	1.14	9.50	66.5	0.89
Seasonal average values, Block X fertilizer experiment, 1953.						
	Hamlin Oranges					
"Nitrogen"						
2-6-8-4-1-½	44.16	10.61	0.99	11.05	60.0	0.88
4-6-8-4-1-½	45.08	10.97	1.02	11.04	60.4	0.91
Seasonal average values, Block XI nitrogen source experiment, 1953.						
	Pineapple Oranges					
"Phosphorus"						
4-0-8-4-1-½	42.92	12.59	1.23	10.38	73.5	1.05
4-6-8-4-1-½	44.47	12.12	1.04	11.85	68.4	1.01
4-18-8-4-1-½	45.57	11.80	1.04	11.64	61.8	0.98
Seasonal average values, Block VIII phosphorus experiment, 1953.						

[1] Based on fruit of 12° Brix with 5.5 gal. juice yield per box valued at $1.00.

[2] N-P_2O_5-K_2O-MgO-MnO-CuO, 4-6-8-3-1-½ (Zinc is supplied as a dormant spray using 3 pounds of zinc sulfate plus 1 pound hydrated lime per 100 gallons of spray.)

TABLE 4

Effect of varying amounts of potash supplied in the fertilizer on sized and randomly collected samples of Valencia oranges

Treatment	Juice by weight %	Soluble solids %	Titratable acid %	Ratio solids/acid	Vit. C mg./100 ml. juice	Approx. value per box[1]
"Size 216"						
4-6-0-4-1-½	53.03	11.90	0.86	14.63	40.8	0.99
4-6-8-4-1-½	53.24	12.42	1.09	12.07	50.8	1.03
4-6-16-4-1-½	52.55	12.48	1.08	12.35	51.1	1.04
"Random Size"						
4-6-0-4-1-½	54.64	11.41	0.87	13.16	45.5	0.87
4-6-2-4-1-½	53.04	11.50	0.91	12.74	46.9	0.94
4-6-8-4-1-½	52.62	11.13	0.93	12.03	46.5	0.90
4-6-16-4-1-½	50.94	10.52	0.88	12.03	46.1	0.75

[1] Seasonal average values, Block XVII potash experiment, 1953. Based on 12° Brix fruit with a 5.5 gal. juice yield per box valued at $1.00.

Use of the new chelated iron compounds for correcting iron deficiency in citrus has provided data showing the effects of this deficiency on the quality of citrus fruit. Table 5 presents the average composition of juice of Valencia oranges from trees severely iron-deficient and from trees corrected of iron deficiency. Fruit from severely iron-deficient trees was found to be characterized by low soluble solids content of the juice, a slight increase in citric acid and vitamin C content, a reduced ratio and a slightly reduced juice content *(14)*.

IMPORTANCE OF FRUIT SIZE

The fact that juice characteristics vary in relation to fruit size is often not sufficiently appreciated. Table 6 shows differences in juice composition of a large lot of Valencia oranges from trees receiving the same cultural treatment, randomly sampled after sizing in the packinghouse. It is apparent from these data that fruit size is of considerable importance to

TABLE 5

A comparison of Valencia oranges from iron-deficient and from non-deficient trees[1]

Condition	Soluble solids %	Titratable acid %	Ratio solids/acid	Vit. C mg./100 ml. juice	Approx. value per box[2]
Severe Iron Deficiency	9.94	1.17	8.51	45.4	0.79
No Iron Deficiency	11.44	1.13	10.18	43.2	0.94

[1] Sites, John W., C. D. Leonard and I. Stewart. Citrus fruit quality as affected by iron deficiency and its correction. Fla. Agr. Exp. Sta. *Ann. Report*. 1953.

[2] Based on 12° Brix fruit with a 5.5 gal. juice yield per box valued at $1.00.

TABLE 6

Effect of size of fruit on juice characteristics of Valencia oranges[1]

Size	Juice by weight %	Volume of juice per fruit-ml.	Soluble solids %	Titratable acid %	Ratio solids/acid	Vit. C mg./100 ml. juice
324	52.38	63	13.25	.71	18.66	44.6
288	54.60	71	12.85	.63	20.40	37.7
250	55.63	86	12.70	.61	20.82	35.6
216	53.33	95	11.90	.56	21.25	33.8
200	54.93	111	11.70	.57	20.53	34.0
176	49.42	113	10.95	.52	21.06	29.9
150	48.93	120	10.60	.52	20.38	29.1
126	46.24	118	9.90	.49	20.20	28.0

[1] From randomly selected fruit picked June 9, 1952. (Unpublished data, John W. Sites and E. J. Deszyck.)

processor and grower alike. The Florida production program is aimed at trying to produce fruit of medium size and good quality. This is being accomplished to some extent through recent changes in fertilizer practices in which less potassium and more nitrogen is supplied to citrus trees *(8)*. Florida Valencia oranges have a tendency to develop rather large in size and they frequently do not set as heavily as would be desired. Increased nitrogen tends to cause a heavier fruit set and this, combined with a reduced potash supply, tends to reduce the average size of the fruit.

The primary objective in the development of the citrus fertilizer program has been to supply the needed elements in adequate amounts to insure optimum production and fruit quality while at the same time to avoid unnecessary application of any fertilizer ingredients wih the attendant increased fertilizer costs.

PEST CONTROL

Processors of frozen concentrate are primarily interested in the juice of the fruit. External appearance of the fruit is therefore not of especial interest. Realization of this fact brought a gleam to the eye of the Florida grower. With pest control accounting for approximately 35% to 40% of the production costs, there appeared to be considerable saving in view if the control of rust mites and melanose were no longer important except for fruit going to the fresh fruit market. The control of rust mites with sulfur is time consuming and expensive. Sulfur has the further undesirable effect of lowering the soil pH, necessitating large applications of dolomite or limestone. All of these factors favored the changing to an inexpensive pest control program for concentrate fruit. Before the fallacy of this idea was comprehended, however, much damage was done. While growers were shaking their heads at the acres of defoliated trees, researchers were busy trying to account for the marked increase in distribution and intensity of the "greasy

spot" condition responsible for the defoliation. This malady (the exact cause of which is still undetermined) has been present in Florida for many years, but never to the extent which occurred following short-cuts in pest control programs for concentrate fruit production. For years mite control had been religiously practiced to protect the fruit and keep it bright. It is now apparent that protection of the *leaves* from mite attack is extremely important. The short-cut programs have not been satisfactory and best control of greasy spot has been found correlated with a complete spray program *(19)*.

Insect and disease pests and their control present a major problem to the citrus grower and may drastically affect the quality and amount of fruit produced. The effect may result directly from the pest or indirectly from the control measure employed. The use of oil in the control of scale insects is a good example of the latter. Although oil is quite satisfactory as a control for scale, it is harmful to the tree and reduces the internal quality of the fruit produced *(17, 18, 20)* Table 7 presents data showing the marked decrease in soluble solids, titratable acid, and vitamin C content which resulted when oil sprays were used for scale control as compared to parathion. Parathion is equally as satisfactory as oil as a scalicide and has no harmful effects on fruit quality. Although parathion is more expensive than oil, the net return to the grower who sells fruit on an assay basis is greater where scale is controlled by parathion because of the higher soluble solids content of the fruit. Further, the harmful effect of oil sprays is related to the time of application. Oil applied later than July 15 usually results in a severe reduction of the soluble solids, acid, and vitamin C content of the fruit.

EFFECT ON QUALITY OF OTHER IMPORTANT FACTORS

Irrigation. Research in irrigation practices has demonstrated that the internal quality of the fruit may often be affected *(6, 16)*. Trees grown under conditions of continuous and abundant soil moisture tend to produce fruit high in juice, low in soluble solids, and low in acid content. The use of irrigation during prolonged drouth periods to protect trees and crop is highly recommended. Greater attention should be given, however, to the timing of the irrigation application. Both fruit quality and yield may be adversely affected by excessive or poorly timed applications (Table 8).

Hedging. The trees in many of the older Florida citrus groves are becoming large and the branches are interlocking with surrounding trees. To combat the high cost of hand pruning, as well as to make pest control easier and let more light into the grove, a mechanical hedging machine was developed *(7)*. The time required for hedging a grove can now be reduced to less than one-half the time previously required, even if the hedging is "hand finished." The ultimate effect of increased light on fruit quality in these groves has not been ascertained but research has shown that light, rind color, and soluble solids content of the fruit are related, and that fruit on the outside of the tree has better color and a higher soluble solids content *(15)*. Better quality fruit, easier picking, and a better pest control operation all seem to be related to this recent development.

Weather conditions. Notwithstanding the effects on fruit quality and production previously attributed to other factors, weather conditions, over which the grower has no control, also influence the quality and amount of fruit which may be produced. Preliminary results indicate that quality of fruit is inversely related to the total annual rainfall. There are exceptions to this trend in certain years, probably because of unequal rainfall distribution *(16)*. It has not been established with certainty whether the differences between seasons are due to soil moisture, or to other weather conditions associated with rain, or combinations of both.

CONCLUSION

In spite of the many achievements which have been made in formulating a satisfactory citrus production program for Florida, there are, as would be expected, still many problems. The threat of "spreading decline" and the development of a satisfactory control; the increasing size of the older citrus trees and the difficulty of adequately spraying them for disease and insect control

TABLE 7

Effect of oil and parathion sprays on the juice characteristics of Pineapple oranges [1]

Spray material	Date of application	Juice by weight %	Soluble solids %	Titratable acid %	Ratio solids/acid	Vit. C mg./100 ml. juice	Approx. value per box [2]
Parathion	July 15	49.48	11.66	1.18	9.97	63.8	0.88
Oil	July 15	49.23	10.93	1.14	9.73	57.4	0.83
Parathion	August 15	46.06	11.62	1.21	9.76	61.0	0.88
Oil	August 15	49.16	10.46	1.14	9.28	51.1	0.79

[1] Seasonal average values from samples collected from November through January. Work done in cooperation with W. L. Thompson, Entomologist.
[2] Based on 12° Brix fruit with a 5.5 gal. juice yield per box valued at $1.00.

TABLE 8

Juice constituents of oranges as affected by irrigation in March, May and November of 1949 [1]

Treatment	Brix	Titratable acid %	Ratio solids/acid	Vit. C mg./100 ml. juice	Volume of juice per fruit ml.	Soluble solids per fruit gm.
Hamlin Oranges						
Irrigated	8.63	0.86	10.44	51.5	74	6.56
Non-irrigated	9.05	0.98	9.58	57.5	70	6.52
Pineapple Oranges						
Irrigated	9.48	0.90	11.36	60.4	83	8.15
Non-irrigated	10.85	0.98	11.44	66.0	84	9.55
Valencia Oranges						
Irrigated	10.65	0.83	13.56	59.5	105	11.61
Non irrigated	11.59	0.96	12.71	53.7	104	12.63

[1] Sites, John W., Herman J. Reitz and E. J. Deszyck. Some results of irrigation research with Florida citrus. Fla. Sta. Hort. Soc. *Proc.* (1951).

are but a few of the problems of corncern to Florida growers. The added production of some 50,000 acres of citrus which will come into bearing during the next 3 years *(12)* and the marketing of this fruit, presents still other problems. How successfully these may be dealt with is unpredictable but optimum production of high quality fruit is considered the best approach.

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Notes and Letters

Fruit Drained Weight Changes

It is normal practice in the food processing industry to open representative samples of a product the day after packing. These samples and the data provided thereby serve as an important aspect of quality control. Unfortunately, part of the data so obtained is limited in significance because an extended period of time is required for the contents of a container to reach equilibrium. This factor is particularly critical with fruits and is affected by such common variables as fruit maturity, syrup strengths, processing, etc.

Besides the legal requirements to be met, many sales are predicated on equilibrium condition. It is therefore important to be able to correlate 24-hour data with equilibrium data. For syrup strength, this can be readily accomplished by blending the entire contents of a container in a Waring blender for 30 seconds, measuring the sugar content refractometrically, and applying a correction factor to give an equilibrium Brix value.

No such simple approach is possible in the matter of drained weights. Each processor must set up carefully controlled lots to be sampled at prescribed intervals of time. Unfortunately, the data so obtained are too late to be of value currently, and may or may not be subsequently applicable.

When data of this type are plotted normally, to show the change in drained weight with time, the results are usually difficult to interpret. If, however, these same data are plotted so that time is expressed on a logarithmic basis, the results closely approximate a straight line. Typical results are shown in Figure 1. These data are from three laboratories, two states and include several fruit types. The fruit was packed in standard commercial cans (401 x 411), each with syrup typical for the product.

A minimum drained weight occurs for most cut fruit usually between 12 and 24 hours after packing. In the case of cherries, however, a minimum value is shown at three days *(3)*, and similar variations in the time of this minimum value may be expected with other fruits. An accurate determination of these first reference points is important during this critical period of most rapid change.

Assuming that the relationship indicated exists, drained weights can be predicted for various storage periods once a reference point has been established. If the slope is determined for an item under specific packing conditions, it should serve not only as a valuable tool in the control of production, but also in evaluating research data.

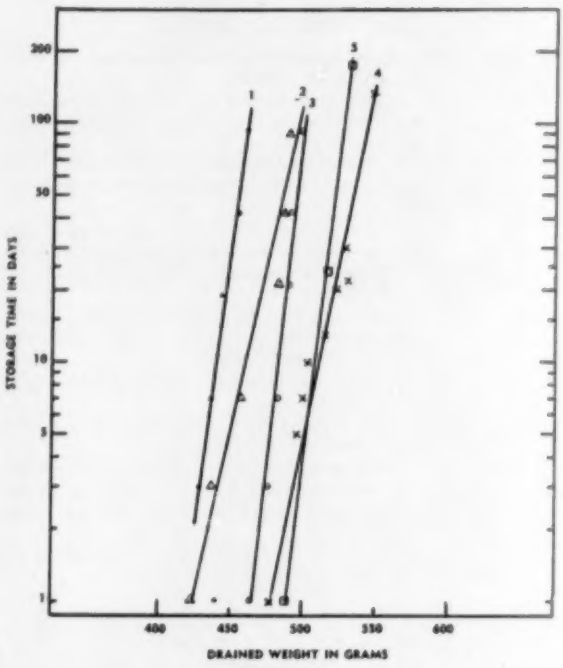

Figure 1

1. Royal Anne Cherries—Washington (2)
2. Freestone Peach Halves—Washington (2)
3. Pear Halves—Washington (2)
4. Yellow Cling Peach Halves—California (1)
5. Yellow Cling Peach Slices—California

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Write to nearest regional secretary, if within an area covered by a regional section, or to the Executive Secretary of the Institute for an application form and information regarding qualifications and classifications.

Awards and Honors

NOTED SCHOLARSHIP AWARDS CONFERRED AT FIFTEENTH ANNUAL MEETING OF IFT

High honors were bestowed upon some capable and hard-working students of food technology at ceremonies conducted at the June meeting of IFT in Columbus, Ohio. The two General Foods Fund Fellowships for 1955-56 were won by two young men who happen to be pursuing their studies a continent apart—Mr. Vincent P. Maier, graduate student in food technology, at the University of California, Davis, and Mr. Harold M. Rich, graduate student in the Department of Food Technology, Massachusetts Institute of Technology, Cambridge. Mr. Rich was the winner of the initial General Foods Fund Fellowship, given for the school year 1954-55.

The national fellowships, established by the General Foods Fund, Inc., 250 Park Avenue, New York 17, New York, are awarded annually to deserving and outstanding citizens of the United States or Canada engaged in senior undergraduate or graduate work in the field of food science. Each fellowship carries a $4000 stipend (per annum). Two awards were made in 1955; in 1956 and thereafter three fellowships will be given by the General Foods Fund Fellowship, Inc.

The 1955-56 Winners

Vincent P. Maier, graduate student on the University of California campus at Davis, has been working for his doctor's degree in agricultural chemistry in the Food Technology Department. He is now working on certain compounds that speed up rancidity in fatty foods. The study is being guided by A. L. Tappel, assistant professor of food technology.

Vincent P. Maier

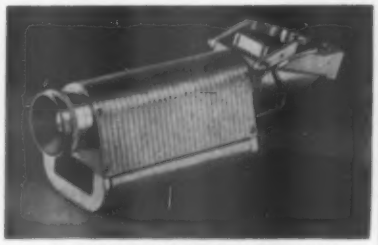
Harold M. Rich

Receiving his bachelor's degree in 1952 on the University's Los Angeles campus Mr. Maier transferred for graduate study to the Davis campus and two years later, received his master's degree in food science at that branch of the University of California system.

Maier is the son of Gustave Maier of 1616 S. Sycamore Street, Santa Ana, California.

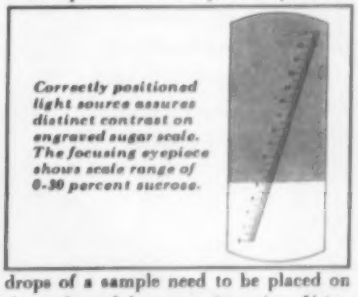
When to Pick or Pack? *Know in Seconds!*

New AO Hand Refractometer Determines Dissolved Solids Instantly!



New AO Hand Refractometer with anodized aluminum finish

Here's real news for food processors and growers! With AO's new Hand Refractometer accurate readings of the percentage of dissolved, solids, particularly sucrose, are made on the spot . . . instantly! Gone is the need for any reference to a thermometer or to temperature correction tables. The secret? AO's design engineers have simplified the temperature correction procedure by means of an exclusive, internal compensating device. Now operation is simple. Only a few drops of a sample need to be placed on the surface of the measuring prism. Using either transmitted or reflected light, the refractometer provides *immediate readings* from an internal graduated scale (range: 0-30 per cent sucrose) which is visible through the focusing eyepiece. Accuracy is assured to 0.1 percent.



Correctly positioned light source assures distinct contrast on engraved sugar scale. The focusing eyepiece shows scale range of 0-30 percent sucrose.

A built-in light source assures ideally positioned illumination under all conditions. Made of anodized aluminum, the new refractometer is light weight, easy to clean. An ever-ready top grain leather carrying case permits use of instrument without removal from case.

If you test raw products for ripeness; if you process fresh juices, syrups, tomatoes, etc., write Dept. S190, American Optical Company; Buffalo 15, New York, for complete information on the new Refractometer. Ask for CATALOG L20.

Light wherever you go! Opening on underside of carrying case shows thumb button for built-in light source

American Optical

INSTRUMENT DIVISION, BUFFALO 15, N. Y.

Mr. Harold M. Rich, of the Department of Food Technology of the Massachusetts Institute of Technology, recipient of a General Foods Fund Fellowship for the school year 1955-56, is a native of Illinois. He received his Bachelor of Science degree from M.I.T. in 1952. During his undergraduate days Mr. Rich was four times on the Dean's list for distinguished studentship and took part in a number of extracurricular activities. Added to his technical and scholastic attainments he has a broad outlook on the food industry for he has worked on a farm, in a cannery, in a produce house, in hotels and restaurants, and in hotel equipment supply houses as well as grocery outlets. He has also seen service as an officer in the United States Army and in this capacity was stationed in Germany for two years. In 1954 he returned to continue his graduate work in food technology. His program of research for the ensuing year is an investigation of the effect of various energy levels of ionizing radiations on the production of induced radioactivity in foodstuffs.

FLORASYNTH AWARD FOR 1955 WON BY IAN J. TINSLEY, OREGON STATE COLLEGE

Mr. Ian J. Tinsley, graduate student in Food Technology at Oregon State College, Corvallis, Oregon, has been named recipient of the Florasynth Award for 1955 by the IFT Committee on Awards. This award is given annually to a young man or woman, under 35 years of age, who possesses outstanding qualities of character and personality, and who has demonstrated scientific or engineering ability in Food Technology in a recognized college of the U.S.A. or Canada. Mr. Tinsley, age 25, came to Oregon State College from Sydney, Australia, where he had obtained a Bachelor of Science Honors Degree in 1949 at Sydney University and had been employed as a Research Officer in the Australian Commonwealth Scientific and Industrial Research Organization, Division of Food Preservation and Transport, from 1950 to 1953. Obtaining leave of absence from his Australian position, he com-

IAN J. TINSLEY

(Continued on page 36)

Is a link missing in your Quality Control Chain?

But he can *be prepared* in advance to spot the trouble *the moment it occurs* by using

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No Food Technologist can tell *in advance* when a batch is going to "go bad."

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You are cordially invited to submit an entry for the

DODGE & OLCOTT, INC.

annual award for outstanding achievement in the

Meat Packing Industry

to be presented

at the Annual Dinner during the

November meeting of the

American Meat Institute

• • •

Award consists of $1000 and a gold medal, and competition is open to any member of the industry, either active or closely associated, who has made a definite contribution to the growth and general welfare of the meat packing industry as a whole.

Nominations may be made in all areas of RESEARCH, OPERATING or ENGINEERING, and there are no restrictions as to age, sex or nationality.

A copy of the rules and an entry blank will be mailed on request. Nominations close on August 1, 1955.

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The pretty maid balancing her pails of foaming milk may have made a romantic picture . . . but today the production and distribution of milk and milk products have become a scientific industry with its own complex technology.

Milk is one of nature's most nutritious products. It is also among the most delicate. So milk and every food product made from milk must be packaged to protect flavor, vitamin content and freshness.

In no other field is it more essential that packaging be tailor-made. Some dairy products cannot withstand light. The sales of others will benefit by a see-through package. Products in liquid form may demand the protection of a hermetically sealed tin can. For many, a waxed cup, polyethylene-coated foil pouch is ideal. A fibre drum is the most efficient package known for bulk shipment of powdered milk.

Since Continental works extensively with both rigid (metal) and flexible materials, we are able to take good care of the dairy products that take such good care of our national health.

Tailor-made packaging for almost everything

With a host of materials to work with, and fifty years of experience at our command, Continental is prepared to give you tailor-made package service for nearly any product you can name. Continental Can Company, New York 17, N. Y. • Continental Can Company of Canada, Ltd., Montreal • Continental Can Company of Cuba, Havana.

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SERVING INDUSTRY SERVING AMERICA

Tin Cans
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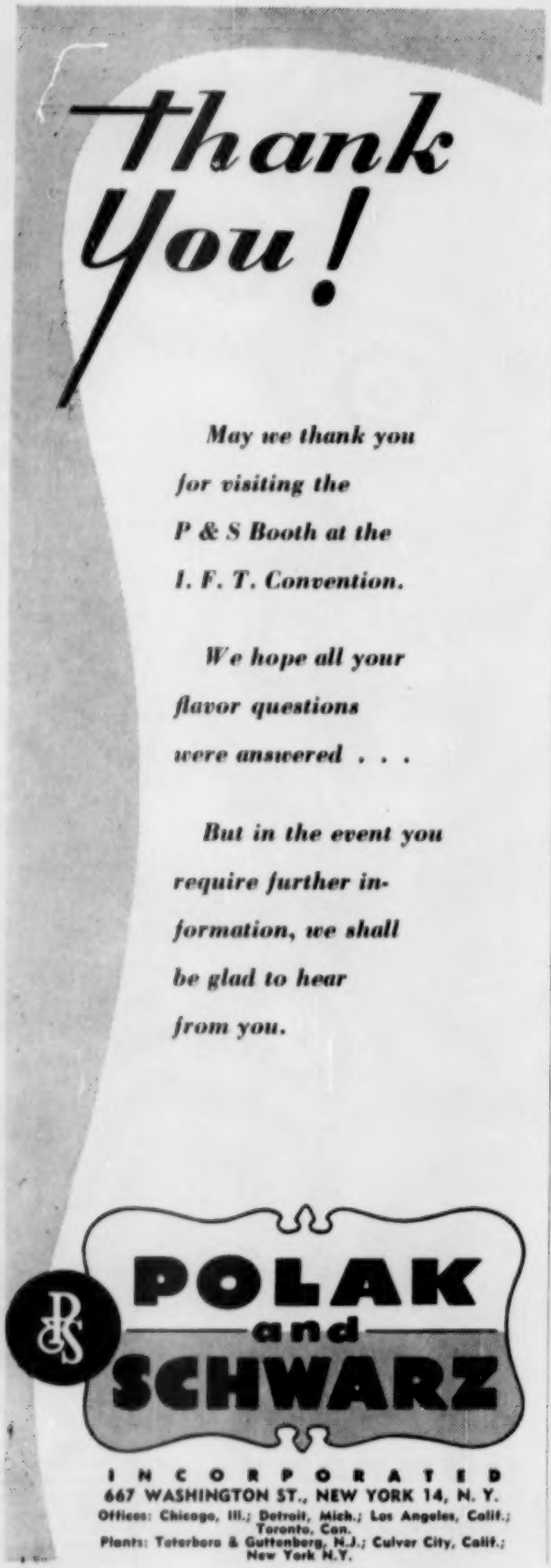
Flexible Packaging
Plastic Pipe
Steel Containers
Crowns and Cork
Plastic Bottles
Decoware®
Conolite®



AWARDS AND HONORS

(Continued from page 32)

menced graduate studies, as a graduate research assistant, in Food Technology at O. S. C. in 1953 and has now received his M.S. degree in Food Technology at this institution. His graduate performance has been of very high caliber and has included research on filbert nuts, on filbert flavor extracts, and on "Methods of presenting samples of raspberries and strawberries to the Hunter Color Difference Meter for color determination." The latter is the title of his Master's thesis. He is continuing at Oregon State College as a graduate research fellow, pursuing studies and research toward a Ph.D. degree in Food Technology. Mr. Tinsley was nominated for the Florasynth Award in recognition of his high character and his outstanding work as a graduate student by Dr. H. W. Schultz, head of the Food Technology Department at Oregon State College. This award, which was announced during the National Meeting of the IFT at Columbus, carries with it an honorarium of one thousand dollars and is provided annually by Florasynth Laboratories, Inc., New York, for the advancement of Food Technology.

D&O ACHIEVEMENT AWARD CLOSING DATE EXTENDED

In order to provide ample time this initial year for the receipt and careful consideration of all entries, the nomination closing date for the 1955 Dodge & Olcott, Inc. annual award, for outstanding achievement in the Meat Packing Industry, has been extended to August 1, 1955. Established in 1954 and announced during the last AMI Convention, the new D&O Award is open to any member of the industry, either active or closely associated, who has made a definite contribution during Award year to the growth and general welfare of the Meat Packing Industry as a whole. Nominations are open in all areas of Scientific Research, Operating and Engineering, and there are no restrictions as to age, sex or nationality. The Award for 1955, the initial year, is still wide open. Applicants should send in an entry now to Achievement Award, Dodge and Olcott, Inc., 180 Varick St., New York, N. Y. Nominations will close on August 1st.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1955	
August 15-19	American Society of Agronomy, Davis, California
September 5-7	American Society for Horticultural Science, Michigan State University, East Lansing, Michigan
September 5-9	American Institute of Biological Sciences, Michigan State University, East Lansing, Michigan
September 6-8	Mycological Society of America, Michigan State University, East Lansing, Michigan
September 11-16	American Chemical Society, Minneapolis, Minnesota
September 14-16	American Fisheries Society, Augusta, Georgia

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

Check 2 New Griffith Antioxidants for

More Oxidative Stability For More Foods At Low Cost . . . . . .

Compare the Performance of these Formulas with that of Any other Antioxidant

Shortening • Lard Fish • Chicken Peanut Oil • Olive and other Vegetable Oils • Citrus Fruit Flavors and Essential Oils

	"G-15"	"G-16"
Highly effective in retarding oxidation for long period in low concentration	YES—Contains Propyl Gallate	YES—Contains Propyl Gallate
Excellent "carry-through" stability after exposure to high (baking) temperatures	YES—Contains BHT and BHA	YES—Contains BHT and BHA
Non-toxic	YES	YES
Imparts no flavor, odor, or color	YES	YES
Develops no flavor, odor, or color during its stabilizing life	YES	YES
Doesn't cause metal-reactive discoloration of product	YES—Contains Patented* Lecithin-Citrate	YES—Contains Monoglyceride-Citrate
Oil-soluble	YES	YES
Water-soluble	—	YES
Reasonable in cost	YES	YES
Packed in convenient non-returnable drums	YES	YES

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. . . in the public interest

The Fatty Acid Division of the Association of American Soap & Glycerine Producers, Inc., has established an annual award to college students for an outstanding paper in the field of fatty acids and/or fatty acid derivatives. The Association has delegated complete responsibility for administration to the American Oil Chemists' Society. Named the Fatty Acid Producers' Award, and consisting of a cash stipend of $500, it will be given to the student or research team submitting an outstanding thesis in the defined area. Final date for papers for this year's Award is September 1, and announcement of the 1955 Award Winner will be made at the A. O. C. S. Fall Meeting in Philadelphia on October 10-12. For information and official entry form, write: Mrs. Lucy Hawkins, executive secretary, American Oil Chemists' Society, 35 E. Wacker Dr., Chicago, Ill.

◆ ◆ ◆

A 9-man taste panel of quality control and research experts decided recently that the 40-kilotron atom bomb fired at Yucca Flat May 5 failed to change appreciably the flavor and color of frozen foods stored in the mock city at the Nevada test site. Samples of codfish, strawberries, orange juice, peas, chicken pot pies, and french fries were exposed in a 17½-cubic-foot home freezer located in the kitchen of a single-story, concrete slab house 4,700 feet from ground zero. Other samples were buried just beneath the soil in an insulated box 1,270 feet from ground zero. It was the first time frozen foods have been exposed to an atom blast. These, together with unexposed frozen food samples, were scored for color, flavor, texture, and appearance under the auspices of the National Association of Frozen Food Packers. Mr. H. P. Schmitt, NAFFP research director, said the taste test showed "very little difference between the samples positioned at 1,270 feet and those at 4,700 feet," par-

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EXCHANGE BRAND ORANGE SERUM AGAR #77

(Dehydrated) a Complete Culture Medium

FORMULA		
Ingredients—when rehydrated on basis of 45 grams per liter of medium.	Orange juice serum solids	12.6g*
	Agar (dry basis)	15g
	Peptone	10g
	Yeast hydrolysate	3g
	Reducing sugars, total	8g
	Sucrose, total	6g
	Cysteine hydrochloride	0.001g

Buffered with 0.2 to 0.6g K_2HPO_4 to provide pH 5.5 ± 0.05 after sterilization.

**Equivalent to 100 ml 12° Brix orange juice serum.*

STANDARDIZED for uniformity and stability.

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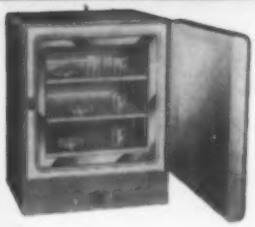
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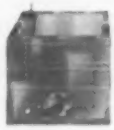
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ticularly interesting in view of the fact that the buried metal box at 1,270 feet was still "hot" until 2 days after the shot. The foods, however, still frozen upon removal, showed only nominal radiation—comparable to that of a radium watch dial. Mr. Schmitt was assisted throughout the project by Dr. K. G. Dykstra, manager of Birds-Eye Laboratories.

◆ ◆ ◆

The American Sanitation Institute, a division of The Hugé Company, Inc., 884-886 Hodiamont Ave., St. Louis 12, Mo., has announced that it will offer throughout a selected group of representative cities during the coming year a one-day sanitation short course. The clinic will emphasize practical methods of developing and maintaining a successful food plant sanitation program. Demonstrations will be offered of what is really working in plants today for curing special problems. Cities to be visited include Louisville, Cincinnati, Columbus, Indianapolis, Chicago, Detroit, Minneapolis, Omaha, Kansas City, Dallas, Houston, and New Orleans. Dates will be announced.

◆ ◆ ◆

An awards competition for the best match books of the year, covering each of 46 industries and including the food industry, has been announced by the Match Industry Information Bureau, 500 Fifth Ave., New York 36, N. Y. Entry forms are available from the Bureau without obligation, and a bronze "Joshua" plaque (after Joshua Pusey, Philadelphia inventor) will be awarded for the entry in each industry adjudged best from the standpoint of selling copy, artwork, and typography. A panel of judges prominent in advertising and marketing circles will select the plaque winners and will also award additional "certificates of merit" for top contenders in each industry. Closing date for entries is September 1, and all match books in current circulation will be eligible.

◆ ◆ ◆

The new and improved foods created for the American housewife are a major factor in the fabulous growth of the food industry today, according to Mr. Paul S. Willis, president, Grocery Manufacturers of America. "In 1939, the average grocer handled about 1,000 items. In today's markets we find all the way from 4,000 to 7,000 items. Since 1939, the food industry has grown from a $16 billion business to $64 billion." In discussing the advertising and merchandising of new products, he mentioned development of a research technique called "motivation research." He said that manufacturers and retailers cannot use the same appeal all the time to attract the interest of the housewife. "Women, with their new independence and broader outlook, are found to respond to many appeals," said Mr. Willis. "They like to be slightly different and original. They are anxious to achieve menu variety. They react positively to products

which they feel reflect their own personality. They like products which offer them the convenience and saving of needless time and effort—while leaving them time to be creative."

◆ ◆ ◆

Submission of nominations for the annual Dodge & Olcott, Inc., Annual Award for outstanding achievement in the meat packing industry has been extended to August 1. The award consists of $1000 and a gold medal. Nominees must have accomplished outstanding work of real benefit to the meat packing industry. Any member of the industry, either active or closely associated (except D&O employees) is eligible and may submit as many nominations as desired. Entries may be submitted from any area of development that contributes directly to the growth and welfare of the meat packing industry. There are no restrictions as to age, sex, or nationality. Nominations should be submitted in the simplest and most concise form possible (the award to be granted on the basis of value of contribution only) and mailed to: Achievement Award, Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y. Seven copies of each nomination must be sent.

. . . *things new under the sun*

A real "toughy" in the field of plastics was previewed recently by the Koppers Company, Inc., Pittsburgh 19, Pa. Pieces molded with **a new "hybrid" of the polyethylene family,** heretofore best known for its adaptation to the squeeze bottle, were "steam-cooked" without losing shape, withstood blows of 32 foot-pounds per square inch without breaking after being cooled to minus 78° F., and, in pipe form, successfully held pressures as high as 1000 psi. The improved plastic is expected to open broad new avenues of use to plastic materials. Developed from basic European patents, the material will be marketed under the Koppers trade name of Super Dylan polyethylene.

◆ ◆ ◆

A new low price resulting from commercial scale production went into effect on beta carotene May 2, it was announced by Hoffmann-La Roche, Inc., Roche Park, Nutley 10, N. J. New base price to manufacturers is $100 per kilo less than the previously prevailing $500 per kilo. Because crystalline beta carotene is photosensitive, difficult to handle and, even when packed in sealed containers under inert gas, tends to lose vitamin A activity, Hoffmann-La Roche has announced a more practicable form for use by food processors. This is a 24% semi-solid suspension of crystalline material in vegetable oils, in 3- and 33-lb. containers. In this form, carotene has proved quite stable and the addition is easily made to batches of food products. For margarine manufacturers, the firm is offering blends of beta carotene with vitamin A, as well as vitamin D, in freely flowing vegetable oil, custom packed in cans to meet the batch requirements of each plant.

◆ ◆ ◆

A new model recording spectrophotometer based on the Beckman DU Quartz monochromator has been announced by the Beckman Division of Beckman Instruments, Inc., Fullerton, Calif. Designated the DK-2, it features an extended range of 200 millimicrons to 3 microns, plus recording linear in transmittance, linear in absorbance, or direct in energy. Of particular significance is the unit's utilization of a true double-beam optical system with a single photodetector and ratio recording. This is the most linear and accurate double-beam system known and provides maximum sensitivity for differential recording. A wide selection of recording speeds permits rapid scanning as well as the ultimate in resolution. A built-in recorder presents data on file-size preprinted chart paper. Standard printed charts are available for the most common ranges on translucent paper for easy ozalid reproduction. A wide variety of absorption cells is available as well as a flame photometry attachment. Write for Bulletin 377.

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Glowing messages now can be put across with 70% more effectiveness with the use of a **new fluorescent Visual Aid Kit** offered by Ultra-Violet Products, Inc., 5114 Walnut Grove Ave., San Gabriel, Calif. The striking materials are activated by long-wave ultraviolet lamps (black light), which the firm also manufactures. Included in the 68-piece Blak-Ray kit are chalks, crayons, tempera colors, colored yarns, assorted cardboards, invisible ink, mechanical pencil with invisible lead, and grease pencils. These also can be purchased individually.

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Ascorbic acid (vitamin C), an essential vitamin, today is proving one of the most effective antioxidants for use in soft drinks, according to Mr. E. F. Macdonough, Jr., manager of the Food and Beverage Section, Technical Service Dept., Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn, N. Y. "It has been shown by mounting evidence," he said, "that in addition to its inherent properties, ascorbic acid can be used to preserve effectively the flavor and color of soft drinks." He explained that many of the flavoring materials used in carbonated beverages are easily susceptible to oxidation. "By 'preferential' oxidation, however, the ascorbic acid is oxidized, thereby saving the flavor," he explained. Mr. Macdonough pointed out that ascorbic acid, acting as a reducing agent, also protects fruit colors subject to oxidation. Here, too, he added, ascorbic acid acts as an "intercepting agent" and averts the oxiding action on the added color.

Pfizer also announced availability of the non-caloric sweetener, calcium cyclamate, for use in preparation of dietetic products requiring low sugar content. The company will offer calcium cyclamate, through its Chemical Sales Division, as a white free-flowing material in 5, 25, and 100 lb. fiber drums with polyethylene liners. Prices range from $3.85 per lb. in 5 lb. containers to $2.95 per lb. in 5,000 lb. quantities.

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The Liquid Carbonic Corporation is offering 2 insulated trailers for free demonstration of commercially available units employing dry ice as the sole

refrigerant. Two systems of refrigeration are featured, both non-mechanical and automatic to maintain temperatures between 0° and 60° F. Insulation and stripping characteristics of the trailers are of advanced design. The trailers are made available at no charge in the interest of promoting improved protection for perishables in highway and piggy-back operations. For free demonstration, write The Liquid Carbonic Corp., Compressed Gas Sales Dept., 3100 S. Kedzie Ave., Chicago 23.

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Low-cost, offset printing plates for office-type duplicators can be produced in one minute by a method announced today by Eastman Kodak Co., Rochester 4, N. Y. The method employs the Kodak Verifax Copier, an office photocopy machine widely used for making quick copies of letters, reports, and other business papers where a limited number of copies is required. By using a new type direct-image paper plate in place of the copy paper ordinarily used, a master is produced which can be placed on an offset duplicator for printing hundreds of copies. The entire operation is carried out under normal room illumination. Any typed, printed, drawn, or written original may be copied by the new method. Printed pictures from coarse-screen newspaper clips may be reproduced. Total materials cost is only 18c. Speed of the method makes possible substantial savings in labor costs.

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The National Filter Media Corporation announces a **new neoprene impregnated filter paper** with a wet bursting strength of 75 pounds per square inch or more. This paper shows good chemical resistance, is free-flowing, economical, and in many applications it can replace cloth or extend cloth life. Super-Netone filter paper is available in several weights, plain or crepe finish. Samples on request. Write c/o Sanger-Funnell, Inc., 60 E. 42nd St., New York 17, N. Y.

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Falls Industries recently combined the uses of "Impervite" (resin-impregnated graphite) and "Graphi-tite" (carbon-impregnated graphite) to produce a practical, economical cascade cooler of standard design which permits efficient cooling of corrosives at temperatures up to 700° F. in the open atmosphere. Specific information on high temperature impervious graphite processing equipment will be furnished by Falls Industries, Inc., 31885 Aurora Rd., Solon, O.

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Motor stocking has been greatly simplified with the **new L. A. line of electric explosion-proof motors,** according to recent announcement by the Louis Allis Co. Underwriters' approval has been received for these units for use in all Class I, Group D, and Class II, Groups E, F, and G hazardous locations. Every new L. A. line explosion-proof motor carries a label indicating approval for use in all 4 of these hazardous locations. Stocking problems are greatly reduced because a single motor can be used for most hazardous locations. The motors are available in ratings of 1 to 25 h.p., 3-phase, and 1 to 3 h.p., single phase. Modifications of the 3-phase motors are available also with Underwriters' approval for use in Class I, Group C, hazardous locations. Write Louis Allis Co., c/o Hoffman & York, Inc., Century Bldg., Milwaukee 3, Wis.

the greatest advance in meat seasoning

Scientifically manufactured MAGNA SPICE CONCENTROLS have modernized the seasoning of meats by making available the true flavor components of herbs and spices in the most concentrated form known to Science . . . yet easily processed in your own plant. All the flavor is released immediately. Each batch of your product is uniformly and identically seasoned.

- Out perform crude herbs and spices.
- Easy to measure — easy to mix.
- No spoilage.
- Cut seasoning costs up to 40%.

Write for the new MM&R booklet — "The Greatest Advance in Meat Seasoning."

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Since 1895 • One of the World's Greatest Suppliers of Essential Oils and Flavors

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Eastman offers widest range of antioxidants

If your food product needs protection against rancidity, bad odor or off-flavor caused by oxidative deterioration, Eastman can help you.

Eastman is the leader in food-grade antioxidants. The leader in volume . . . in experience . . . in accumulated data.

No other manufacturer can offer such dependable counsel in the proper use of antioxidants for the stabilization of foods.

The effectiveness of Eastman recommendations and Eastman Tenox antioxidants has been proved on the following products:

Animal Fats and Oils	Cosmetics
Vitamin A	Monoglycerides
Cereals	Cookies
Butter Fat Concentrate	Essential Oils
Fish and Fish Meal	Citrus Oils
Chewing Gum	Potato Chips
Meat Products	Dog Food
Crackers	Premixes
Paper Board	Spices
Dairy Products	Wax
Chicken Fat	Candy
Vegetable Fats and Oils	Nuts

Don't let rancidity cause returns, losses and dissatisfied customers. Look into the simple remedy of antioxidants. Their cost is low.

Eastman will be glad to recommend an antioxidant treatment or even undertake a testing program for whatever food product you wish to stabilize. The recommendations you receive will represent the most effective treatment at the lowest possible cost. For Eastman offers a full range of antioxidants and has no axe to grind in favor of any one antioxidant. We make them all!

For more information about Tenox, write to Eastman Chemical Products, Inc., Kingsport, Tennessee—a subsidiary of Eastman Kodak Company.

Tenox Eastman Food-grade Antioxidants

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tenn.; New York — 260 Madison Ave.; Framingham, Mass. — 65 Concord St.; Cincinnati — Carew Tower; Cleveland — Terminal Tower Bldg.; Chicago — 360 N. Michigan Ave.; St. Louis — Continental Bldg.; Houston — 412 Main St. **West Coast: Wilson Meyer Co.,** San Francisco — 333 Montgomery St.; Los Angeles — 4800 District Blvd.; Portland — 520 S. W. Sixth Ave.; Salt Lake City — 73 S. Main St.; Seattle — 821 Second Ave.; **Canada: P. N. Sedon Co., Ltd.,** Montreal, Quebec — 2143 St. Patrick St.; Toronto, Ontario — 1498 Yonge St.

For applications where it is desired to bring high-speed counting indications to a remote monitoring point, the **new Model 650 Rayconter** has been developed. This unit is capable of displaying with high accuracy counts of 3600 per minute, actuated over a pulsing circuit of any reasonable length using either line or low voltage as specified. Operable at rates of 3600 counts per minute, the Model 650 will contain 999,999 counts, and is supplied as a unit with the counter and impulse receiver mounted in a slant-front metal box with 2 rear-mounted terminals for connection to the pulsing circuit. Write Rayeon Corp., 194 Harbor Blvd., Belmont, Calif.

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A new, complete line of highest quality laboratory stirrers is offered by Talboys Instrument Corp., 13 Ackerman Ave., Emerson, N. J. The line is backed by 19 years' design experience and is called the T-Line of laboratory stirrers. A descriptive catalog sheet shows each model and its specifications. These include direct drive stirrers, gear drive stirrers, and stirring paddles.

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Techniflex Corp., Port Jervis, N. Y., announces release of its **floatless type level control unit,** an adaptation of probe type level control units applied to industrial equipment. The standardized design for domestic and medium size commercial installations provides an economical and easily installed unit with a power requirement of 110 volts a.c. By means of a transformer contained within the sealed control box, all signal voltages are reduced for the complete elimination of any electrical hazard. The vessel containing the probe is marked externally to show the Low Water Level. When water level falls below the probe tip, control and/or alarm action is called in via the relay contained in the sealed control box. As an additional precaution, the unit is designed to act in a fail safe manner. Where a controlled level range is required and difference between high-low levels does not exceed 6", two probes are furnished in one vessel.

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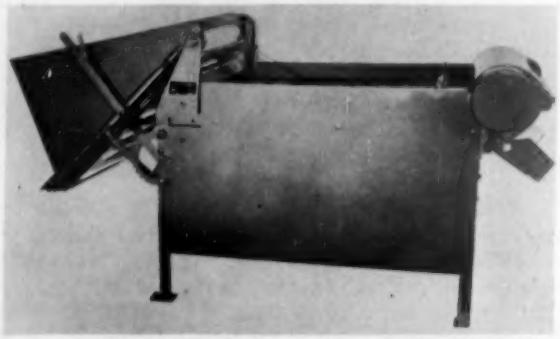

Three hundred per cent greater capacity and automatic operation are the outstanding features of the IMPROVED FMC HI-SPEED FRENCH STYLE BEAN SLICER manufactured by the Canning Machinery Division of Food Machinery and Chemical Corp., P. O. Box 1120, San Jose, Calif., and Hoopeston, Ill. Output of this compact machine (illustrated) has been increased up to 4 tons per hour for blanched beans, and up to 3½ tons per hour on raw beans through design changes which provide for faster and more efficient alignment of beans in the machine. The fully automatic Slicer can be adjusted to meet the demands of the line load simply by adjusting the elevation of the feed hopper and the incline of the aligning bed. Dimensions are 5'6" long, 3'6" wide, and 3'7" high. The company also announces exclusive sales rights throughout the U. S., Canada, and overseas for the Carruthers' Multi-Pak Filler. The unit reportedly automatically fills whole or French-sliced green beans at capacities up to 15 times greater than those obtained by hand-pack methods.

A new FEON chemical-resistant synthetic filter felt, made of tightly compacted resin-bonded fibers of Dynel, has been announced by Filtration Fabrics Division of Filtration Engineers, Inc., 155 Oraton St., Newark 4, N. J. Principal applications will be for pressure filters and centrifuges. FEON Dynel is virtually unaffected by most concentrated mineral acids and bases, and is very highly resistant to a variety of organic acids, bases, and salts. The new felt is easy to clean and has a structure which retains fine solids, yet has a relatively high porosity permitting high filtering rates. The felts have bursting wet strengths of from 200-350 pounds per square inch, which is more than required for filtering applications.

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Glucose-oxidase-catalase is now available in a concentrated aqueous solution, clear and stable, at room temperature. The enzyme is useful in removing glucose or small quantities of oxygen. Particularly applicable when clarity is important, and without the need for an extra filtration, the enzyme may be used "as is," with no preparation of "stock solution" required. The product is available in 2 types: Ova-Zyme, for stabilization of eggs, and Fermco-Zyme, for stabilization of canned beverages and foods. Write Fermco Chemicals, Inc., 4941 S. Racine Ave., Chicago, Ill.

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A ½-oz. protective mask workers enjoy wearing because of its light weight is made of soft rolled aluminum, so pliable that it fits any shape face. It is intended for protection against ordinary non-toxic dusts and spray hazards, and may be worn with goggles. No metal touches the skin. The effectiveness is seen by the filter discoloration, caused by dust, as indicated on the photograph. GS No. 48A masks cost only 30c each. Extra refills are $2 per 100. For information or trial order, write: General Scientific Equipment Co., 2700 W. Huntingdon St., Philadelphia 32.

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A new molded fiberglass stock box for candy makers and other food processors has been developed by the Molded Fiberglass Tray Co., Linesville, Pa. It has the distinct advantage of sealing out dust when the boxes are stacked. The new "no-maintenance" Toteline stock boxes last indefinitely, can't be dented or bent, and their non-porous surfaces won't splinter or absorb odors. The boxes' reinforced corners are rounded for improved cleanliness. Dimensions are 16½" long x 11⅜" wide. Each box weighs 3½ pounds, and is 4¼" deep when stacked.

. . . the literary corner

While businessmen are deploring governmental gobbledygook, a dozen Philadelphia technical writers were warned recently not to forget that industrial gobbledygook can be just as wasteful and irritating. The reminder came from Mr. John Stahr, editorial director of Carl Byoir & Associates, Inc., New York

GIVAUDAN PROVIDES POSITIVE SOLUTIONS TO YOUR COUMARIN REPLACEMENT PROBLEMS

GIVAUDAN'S CR #8 AND CR #12 COUMARIN REPLACEMENTS

resemble coumarin to a remarkable degree in odor, taste and flavor strength—and can be used to replace coumarin ounce for ounce in a wide variety of preparations. Proof of non-toxicity in normal use has been provided by an extensive series of tests. C.R. #8 is soluble in alcohol and propylene glycol; C.R. #12, a variation of C.R. #8, is also soluble in vegetable oil. Both, of course, are coumarin-free. Custom-made replacements and their ingredients are also available for those who need special products for particular requirements.

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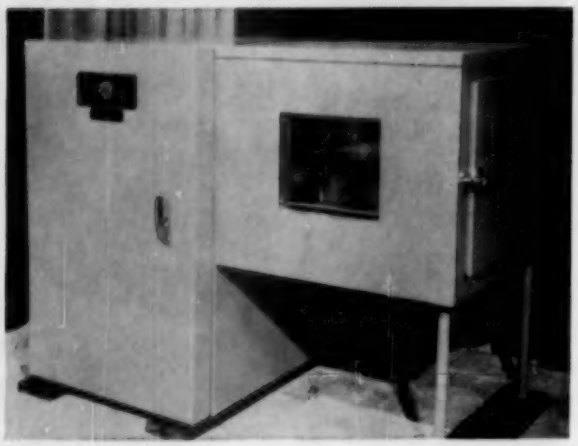

AIR CONDITIONED TEST CABINET

USES—to determine effects of controlled temperature and humidity conditions on test subjects of all kinds—to test processes—to find optimum conditions.

RANGE—With water and electric power services only, the range is from freezing temperature up to 150°F (dry bulb). With refrigeration, and using Niagara No-Frost Liquid to prevent freezing of sprays, you achieve dew point temperatures as low as minus 30° F. Control of relative humidity from 5% to 95% is obtained at all temperatures in this range. Air capacity is 200, 400 or 600 c.f.m.

METHOD—Air is saturated in the air-conditioning unit at the required dew point temperature and reheated to the desired dry bulb temperature. This is the method of the Niagara Type A Air Conditioner which has been proven for the most exacting duty over twenty-five years.

CONTROL—The dew point thermostat is located in the air stream, the dry bulb thermostat in the test cabinet. No moisture sensitive instruments are needed. Recorders may be used to obtain a complete record of conditions.

TEST CABINET—(inside) dimensions are 30" x 28" x 24" with access clear opening 26" x 22". Insulation is the equivalent of 4" cork.

AIR CONDITIONING UNIT is enclosed in an insulated cabinet adjoining the test cabinet. A door the full size of the cabinet wall gives complete access.

Write for Complete Information. Address Dept. F.T.

NIAGARA BLOWER COMPANY

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District Engineers in Principal Cities of United States and Canada

City public relations firm, and was directed at writers for *Instrumentation*, the external technical publication of Minneapolis-Honeywell's Industrial Division, Philadelphia. "Don't be afraid to tell (in print) your fellow engineers about a new process or new product in very nearly the same terms you'd use telling your neighbors about it as you lean over the back fence between turns with the lawn-mower," Stahr said. The speaker also warned against alienating the many important executives who are not highly trained engineers with language that is too stuffy and technical. "You'll never lose or estrange even the most scholarly technical man simply because you tell a story in terms of hard-hitting basic English . . . if the subject matter itself is worthy of his attention in the first place," he concluded.

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Publication of the long-awaited ASME Standard on "Industrial Engineering Terminology" was announced recently. The Standard is a handy 50-page compendium of 500 industrial engineering terms arranged in alphabetical order and running from the initial entry, "abnormal reading," through "written standard practice." Definitions are as brief as practicable, and can be understood even by non-experts in the field. Subjects range from elementary definitions, such as those for industrial engineering or for a standard itself, to an entire series of complex production terms. The work fills an important place in the well-known series of ASME Codes and Standards for safe construction, operation, and testing of elevators, boilers, piping, and screw threads. Copies are available from the Order Dept., The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y., at $1.50 each.

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The color and romance of one of the world's most fascinating industries have been captured in "Facets of Progress," an illustrated booklet issued by Magnus, Mabee & Reynard, Inc., world-famous essential oil firm, on the occasion of its Diamond Jubilee (1895-1955). The publication traces the growth and development of MM&R over 6 decades. Interesting sidelights are thrown on world-wide sources of supply, and on research and control procedures which have played dominant roles in the firm's success. For free copy, address: Advertising Dept., Magnus, Mabee & Reynard, Inc., 16 Desbrosses St., New York 13, N. Y.

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A new Permochart Stock List has been published by Allegheny Plastics, Inc., Thorn Run Rd., Coraopolis, Pa., plastic laminators, printers, and fabricators for industry. Approximately 3,000 of the most widely used Permocharts, all-plastic recording instrument charts, are included on the list. Permocharts are equivalent to 730 paper charts since they are washable, reusable, and guaranteed for 2 years. They can replace any circular charts and require no changes in equipment or ink. Write requesting Form 106 1-55.

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Two new pieces of literature are available gratis from the Research and Control Instruments Division, North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. One is a 4-page bulletin titled

"Norelco MG 60" which gives design details and application data on a new lightweight portable X-ray unit for radiographic and fluoroscopic work in laboratories and industrial plants. The other is a one-page reprint of an article which appeared in a national engineering publication. The title is "Sperry Gyroscope Employs X-ray for Development Problems" and the text describes how this company has reduced time and effort when radiographing many varieties of electrical and electronic equipment.

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The Givaudan Flavorist, No. 2, 1955, studies the development of flavor creation as both an art and a science in the article entitled, "Apple . . . A Good Start." The bulletin is published by Givaudan Flavors, Inc., 330 W. 42nd St., New York 36, N. Y.

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"Should you market that new product? Where should you locate that new plant? Who are the potential users of this product? Is your market saturated?" These are the types of questions discussed in Foster D. Snell, Inc.'s new 12-page booklet, "Marketing and Economic Research . . . Your Problem?" Highlighting the firm's expanded services in this field, the booklet lists 13 significant market surveys. Information generally comes from published and unpublished data and field interviewing. Data from Government statistics, trade associations, and other sources are verified by personal contact. Organizing, interpreting and verifying this information follows. Conclusions are tested against known data. For free copy, write Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y.

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"Better than other data, the new data on proportions of individual crops that are now frozen reflect the major responsibility that frozen foods are discharging in our national food economy," states *Information Bulletin* for April 15, 1955, published by The Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colo. "Freezing," it continues, "is not an expendable frill. It is carrying a major work load. Here are some proportions of crops that are frozen: 20% of poultry, 20% of sea food, 60% of lima beans, 50% of the orange crop, 45% of broccoli, and 40% of the strawberries. These are increasing. There is danger that the concepts of yesterday will affect the planning and programming of the present. Common sense dictates that research and development programs for frozen foods must be based on the major-industry concept. They must be comprehensive—designed to aid a permanent, expanding industry that is necessary to national welfare."

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Automatic Control Systems Bulletin No. S-10 describes in detail how Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Pa., can assist in arriving at the right application of an automatic control system. Case histories are presented along with a description of the scope of ATC Co. services in the phases of design, purchasing, construction, and start-up of packaged Automatic Control Systems. Write Mr. E. G. Murphy, Market Development Manager.

Tenney Engineering, Inc., 1090 Springfields Rd., Union, N. J., announces Bulletin No. 109-55 on their new Angle-Air Unit Coolers. The illustrated bulletin gives full physical specifications and complete application data, from which it is easy to select the proper unit for each refrigeration application.

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A proportioning system that permits remote dialing and weighing of individual feed ingredients is illustrated and described in new 8-page illustrated Bulletin O155, offered by Richardson Scale Co., Van Houten Ave., Clifton, N. J. Besides discussing the operation of the Select-O-Weigh system, the bulletin describes 3 different installations of varied formulating capacities.

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"Selection, Use and Maintenance of Valves," a 20-page comprehensive, basic story on valves is available by writing the Crane Company, 836 S. Michigan Ave., Chicago.

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An 8-page catalog, "Apparatus for Timing—Counting," illustrating 37 items and describing a wide variety of mechanical, electrical, and electronic devices is offered free. Included are electric stop clocks, high speed impulse counters, and printing timers suitable for many industrial and laboratory applications. Write C. H. Stoelting Co., 424 N. Homan Ave., Chicago 24, Ill.

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Prepared with the assistance of leading water treating consulting firms, new 24-page Milton Roy Bulletin 953 describes and illustrates how Controlled Volume Pumps are used in typical industrial water treating systems. Included are coagulation systems, lime soda softening, hot process softeners, demineralization, and various types of boiler water treatment systems. Thorough analysis is given to cooling tower water treating problems as well as methods and systems for waste and sanitary water treatment. Write Milton Roy Co., Station E, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

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"What World Trade Means to the Livestock Industry" is the issue article for Armour's *Analysis*, January-March 1955, published by Armour's Livestock Bureau, Chicago 9, Ill.

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New illustrated Bulletin 113-D on cleaning steel drums in reconditioning, published by American Wheelabrator & Equipment Corp., 1095 S. Byrkit St., Mishawaka, Ind., shows how airless abrasive blast cleaning is being used at a number of plants. Four case histories are presented, as well as photographs of typical machines in use.

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A free 8-page illustrated booklet entitled, "The Story of Willie Bacteria, or How to Take Care of Your Septic Tank or Cesspool," has been made available to owners of septic tanks and cesspools by the Educational Division of the FX-Lab Company, 4 Hill St., Newark 2, N. J. The booklet explains the workings of the septic tank and cesspool in simplified fashion, using cartoon type illustrations. It describes the bacterial action of the disposal system and the nature of the bacteria contained therein which are responsible for the proper functioning of the system.

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A new bulletin outlining the methods and controls used in producing recording instrument charts has been released by The Bristol Company, Waterbury 20, Conn. The 14-page bulletin shows some of the tests and quality control procedures which go into chart manufacture. The company's Socket Screw Division has also released a new series of data sheets listing the physical properties of its line of socket screw products.

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As an aid to management concerned with the problem of controlling insect infestation, the Vacuum Process Division of John Mohr and Sons, 3200 E. 96th St., Chicago 17, Ill., is offering a new illustrated brochure presenting the latest scientific techniques in vacuum refrigeration. Typical applications include methods and equipment designed to meet the requirements of companies processing food, tobaccos, pharmaceuticals, and other products. Advantages claimed for this equipment include shorter exposure periods required and more complete penetration and destruction of insect life.

. . . *meeting hall and conference room*

Convenience for the consumer and cost reduction for the manufacturer were the twin goals of the packaging equipment, materials, and services on display at the American Management Association's 24th National Packaging Exposition in the International Amphitheatre, Chicago, April 20. Among the many items aimed at making life easier for the housewife and processor were a new "pour-sift-store" top for metal containers, developed by American Can Company; a screw-on vacuum cap shown by Crown Cork & Seal Company; vacuum formed acetate packages for roller bearings, which must be packed in oil, displayed by Celanese Corporation of America; Koppers Company's expandable polystyrene, which can be molded to fit the shape of the product; Dow Chemical Company's extruded foam plastic, developed as a replacement for heavier cotton in cartons for antitetanus and antisnakebite vaccines; a new multiple liquid filling machine and a new high-speed rotary tabletting press shown by Arthur Colton Company; and new plastic films featured by Goodyear Tire & Rubber Company and E. I. du Pont de Nemours & Company.

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Two coming events on the calendar of the American Oil Chemists' Society are the 1955 short course on Analytical Techniques at the University of Illinois, Urbana, August 1-5, and the fall meeting at the Bellevue-Stratford Hotel, Philadelphia, October 10-12. Chairman of the former is Mr. G. A. Crapple, Wilson

(Continued on page 48)

PURE VANILLA CONCENTRATE
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an AMAZINGLY EFFECTIVE REPLACEMENT FOR COUMARIN . .

PROTOVANOL "C" is at least 50% stronger in flavoring strength than Coumarin Fine Crystals, is fully soluble in alcohol, propylene, and to an extent even in vegetable oils . . . PROTOVANOL "C" has amazing versatility readily mixed in various dry bases . . . and easily absorbed in cane sugar, corn sugar or starch . . .

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Florasynth's Entrapped Powdered Flavors keep the flavor characteristics so alive, so fresh . . . provide instant solubility in cold water . . . complete dispersability within the mix . . . definitely longer shelf-life. Available for prompt shipment in wide flavor selection . . .

Samples available . . . or for your particular requirement . . . upon request . . .

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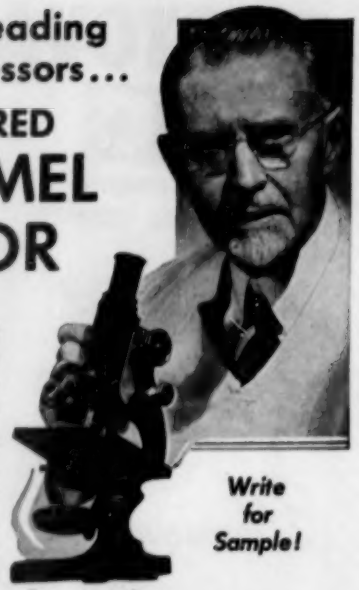

A dehydrated food color, made entirely from dextrose sugar by cooking under controlled conditions.

It has particular use in dry food products where the use calls for a natural color ranging from a light to a very dark brown. For example:

Write for Sample!

Powdered Desserts *Dehydrated Soups*
Dry Cake Mixes *Bouillon Powders*
Powdered Coffee & other beverages
Powdered Gravy Seasonings

S. TWITCHELL CO.
CRESTMONT & HADDON AVES • CAMDEN 4, N.J.

FOOD INDUSTRY TOPICS

(Continued from page 46)

and Company, Chicago, and of the latter, Mr. P. E. Ronzone, C. F. Simonin's Sons, Inc., Philadelphia. Further information may be obtained also from Mrs. Lucy R. Hawkins, executive secretary, AOCS, 35 E. Wacker Dr., Chicago 1, Ill.

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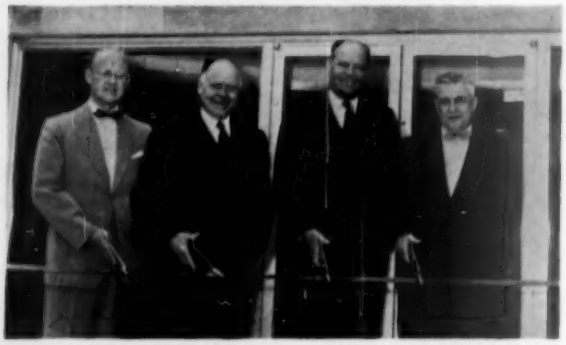
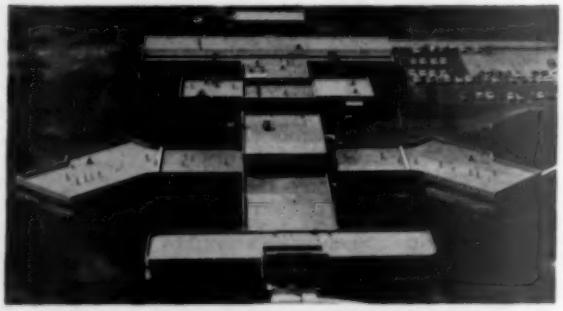
Changing population trends, changing consumer habits and attitudes, as well as developments in the science of food processing, and the marked trend toward automation will affect the advancement of the confectionery industry, according to Mr. Philip P. Gott, president, National Confectioners' Assn., Chicago, who spoke at the annual banquet held in conjunction with the Ninth Annual Confectionery Production Conference sponsored by Pennsylvania Manufacturing Confectioners Association and Franklin & Marshall College on April 28. He cited the greater energies expended in the current "do-it-yourself" trend, the effect that the gradually aging population will have in increasing demand for processing techniques and machinery which will demand a minimum of human attention, and the greater capital outlay that will be required along with greater emphasis upon the stability of profits which will make such expansion and adjustment possible.

The Council of Participating Institutions of Argonne National Laboratory will sponsor a conference on the Use of Isotopes in Agriculture, to be held January 12-14, 1956, at Michigan State College, East Lansing, Mich. Coordinated with this, the American Association for the Advancement of Science and the Oak Ridge Institute of Nuclear Studies will sponsor a related conference on Atomic Energy and Agriculture at the Atlanta, Ga., meeting of the AAAS, December 26-30, 1955. At East Lansing, there will be intensive coverage of laboratory problems, experimental problems and results. The Atlanta session will develop the present status and future outlook for application of atomic energy in agriculture. For further information, write E. W. Phelan, Argonne National Laboratory, Box 299, Lemont, Ill.

. . . *building up and branching out*



Industry and scientific leaders who took part in the dedication ceremonies at American Can Company's new Research and Development Center in Barrington, Ill., cut a ribbon of tinless metal to symbolize the part which Canco scientists are playing in perfecting cans from tin-free materials. Left to right—Mr. Geo. H. Morrill, Jr., president, National Canners Assn.; Dr. R. H. Lueck, vice president of research, American Can Co.; Mr. Wm. C. Stolk, Canco president; and Mr. R. D. Coghill, president-elect of the Industrial Research Institute.



The largest research center in the world devoted to food and containers, the new Canco laboratory occupies 102,000 square feet of floor area and is surrounded by a landscaped 40-acre tract. More than 50 separate laboratory sections house an array of 500 pieces of major research equipment.

◆ ◆ ◆

A West Coast Service Laboratory of the American Meat Institute Foundation has been established through a cooperative arrangement with Geo. W. Gooch Laboratories, Ltd., at 2580 E. 8th St., Los Angeles, Calif., and began operations early in May, according to announcement by Mr. Wesley Hardenbergh, Foundation president. This laboratory ar-

(Continued on page 50)

a Quiz that may save your life

Q. What is cancer?

A. An uncontrolled growth of cells. If permitted to spread through the body, it inevitably leads to death.

Q. Can cancer be cured?

A. Many types can be cured, but only if they are discovered and treated early.

Q. How can cancer be discovered in time?

A. By your doctor who has available many diagnostic tests.

Q. What is the American Cancer Society?

A. The only national voluntary agency which fights cancer by research, education and service to cancer's victims.

Q. What has it accomplished?

A. It helped save an American from dying of cancer on an average of every seven minutes last year.

Q. Does that mean it has solved the cancer problem?

A. Unfortunately, no. Despite the advances made, more than 235,000 Americans will die of cancer this year.

Q. Can I help to prevent this tragedy?

A. Yes. By having regular health examinations yourself. And by contributing to the American Cancer Society.

Q. What will my contribution be used for?

A. For research that may some day save your life, for education and for helping cancer's victims.

Strike back | at cancer . . . man's cruelest enemy . . . Give

American Cancer Society

FOOD INDUSTRY TOPICS

(Continued from page 48)

rangement is designed to provide direct service to Pacific area meat and meat by-product processors, and will feature the same complete technical consultive and analytical services available through the Foundation's Service Laboratory at 939 E. 57th St., Chicago. The West Coast Laboratory will be under the personal direction of Dr. B. W. Beadle, executive vice president of the Gooch Laboratories. Coordination of the technical and service functioning of the new Laboratory with operations of the Service Laboratory and research divisions of the Foundation in Chicago will be under the over-all supervision of Dr. H. R. Kraybill, Foundation vice president and director of Research and Education.

◆ ◆ ◆

National Aniline Division, Allied Chemical & Dye Corp., New York City, has opened its new multi-million dollar Research and Engineering Center. Located at Elk and Peabody Streets, Buffalo, N. Y., adjacent to National Aniline's large 72-acre chemical manufacturing plant, the Center embodies the latest design in scientific facilities. A staff of some 300 chemists, engineers, and technologists at the Center will provide technical service to all operations of National Aniline Division, one of the country's largest producers of dyes, dye intermediates, and synthetic organic chemicals.

◆ ◆ ◆

Mr. R. M. Jackson, president of American Machinery Corporation of Orlando, Fla., announced that a special meeting of stockholders had approved a management-sponsored plan to provide needed new financing. The funds provided by this increase in capitalization will be applied toward debt retirement and will provide additional working capital needed to carry out more economical and possibly expanded operations. It is understood that American Pacrite Corp., a wholly owned subsidiary of Wallace & Tiernan, Inc., and the majority stockholder of American Machinery Corp., intends to exercise its option rights and also to purchase any additional stock not subscribed which may be offered to it by American Machinery.

◆ ◆ ◆

Riegel Paper Corp., 260 Madison Ave., New York 16, N. Y., has placed its new coating tower in full-time production. The new coating equipment permits Riegel to greatly expand present production, as well as to coat new types of paper. It is stated to be the most modern coating equipment in use in this country. The new equipment, with normal and reverse roll coating heads, permits thicker coatings to be applied than on Riegel's 3 coating towers now in use. The coater measures 125 feet long, and will coat a web 66 inches wide. It is located at Riegel's Milford, N. J., mill.

◆ ◆ ◆

Midwest Research Institute, which during the past decade has become one of the top research organizations in the country, formally opened its new $1,250,000 research center in Kansas City, Mo., on May 9. Located on Volker Blvd., between Oak and Cherry Sts., the laboratory will house a staff of 180 scientists and 65 administrative workers engaged in solving technical problems of business, industry, and agriculture, as well as general welfare. Heading the staff are Dr. Chas. N. Kimball, Institute president, Mr. Leon T. Swan, vice president, and Dr. Max H. Thornton, technical director.

◆ ◆ ◆

Durethene Corporation, one of the country's largest manufacturers of polyethylene film for packaging and other purposes, has announced completion of new equipment installations in both their Chicago and Los Angeles plants which will increase their production capacity by 25%. Durethene's main plant in Chicago is at 1859 S. 55th Ave.; Plant No. 2 is at 5600 W. Arbor Vitae St., Los Angeles 45. The greater volume is needed to meet rapidly growing demands for the firm's products in such fields as fruit and vegetable prepackaging, textiles, bakery goods, and for drum and bag liners for the chemical and other industries.

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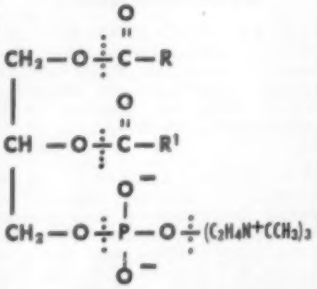

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FOOD INDUSTRY TOPICS

Arthur D. Little, Inc., Cambridge, Mass., has announced establishment of a new management consulting service for industrial and financial groups interested in atomic energy. Spokesmen for Arthur D. Little, Inc., stated that their company's experience in this field should be of particular value to management in defining and developing opportunities for profitable participation or expansion. ADL, they said, will furnish banking and investment houses and industry with technical-economic advisory services on which they may base their financial operations in atomic energy. This service is in addition to their present consulting services on the research and technical level.

. . . *the human element*

The board of directors of the A. E. Staley Mfg. Co., corn and soybean processor, Decatur, Ill., has elected **Mr. W. R. Boyer** company treasurer and assistant secretary, and **Dr. L. S. Roehm** a vice-president. Mr. Boyer, a Staley employee since 1934 and comptroller of the firm since 1948, was also elected to the board of directors. Dr. Roehm, manager of the company's corn division since 1951, was previously assistant general sales manager of the Dow Chemical Co. Newly appointed company comptroller is **Mr. Bernard L. Huffer,** chief cost accountant at Staley since 1948.

◆ ◆ ◆

Mr. Jerome B. Thompson, for the past 5 years in charge of research for the C. J. Patterson Co., Kansas City, Mo., has joined the Research and Development Department of Pillsbury Mills, Inc., as assistant director of the Bakery Mix Laboratories in Springfield, Ill. Mr. A. F. Borer is director.

◆ ◆ ◆

In recognition of his professional accomplishments in science, education, and industry, **Dr. Henry B. Hass,** president of Sugar Research Foundation, Inc., received the 1955 Honor Scroll of the New York Chapter of the American Institute of Chemists at the AIC annual meeting June 2 at the Commodore Hotel, New York City. The award was a tribute to Dr. Hass' advancement of petrochemicals, and his pioneering in the new field of sucrochemistry.

◆ ◆ ◆

Nine appointments at the Central Laboratories of General Foods, Hoboken, N. J., were announced recently by Mr. Harvey Murer, manager. The appointees were: **Mr. Lawrence Lynn** to assistant laboratory director for engineering and commercial development, **Mr. Irving R. Chandler** to project leader in engineering research, **Mr. Harold Rafson** to project leader in engineering research, **Mr. Alexander Apostolina** to associate technologist in product development, **Dr. Maurice S. Fagan** to associate technologist in product development, **Dr. Robert E. Hayes** to associate technologist in product development, **Dr. Salah M. Loutfi** to associate technologist in product development, **Dr. Robert S. Shallenberger** to associate technologist in organic chemistry, and **Mr. Arthur N. Kesselhaut** to junior technologist in product development.

◆ ◆ ◆

Election of **Mr. John M. S. Hutchinson,** formerly works manager of the body and car building assembly of the Chrysler Division of Chrysler Corporation, to the positions of vice president and assistant to the president of The Perkin-Elmer Corp., Norwalk, Conn., was announced recently. Perkin-Elmer is a leading manufacturer of scientific instruments and optical design.

◆ ◆ ◆

Mr. A. L. van Ameringen, president of van Ameringen-Haebler, Inc., New York City, has accepted an appointment as vice chairman of the Mental Health Fund campaign currently being carried on by The National Association for Mental Health. His particular responsibility is the solicitation of contributions among the major industrial companies of the nation.

◆ ◆ ◆

Spencer Kellogg and Sons, Inc., Buffalo, N. Y., announces appointment of **Mr. Edward Handschumaker** to the newly created position of manager of Edible Products Research. According to Dr. Malcolm M. Renfrew, director of Research

FOOD INDUSTRY TOPICS

and Development, Mr. Handschumaker will work with Spencer Kellogg's vegetable shortenings, salad oils, and soybean flour in an expanded program for the development of new food products.

PUBLICATION OF LOCAL SECTION PAPERS OF TECHNICAL MERIT

Good technical papers, worthy of publication in FOOD TECHNOLOGY as articles or, in condensed form, as contributions to "Notes and Letters" are presented from time to time before local sections of IFT. The Committee on Publications has suggested that the program committee of local sections urge authors of such papers to submit copies to the Editor of FOOD TECHNOLOGY for review and possible publication.

Inquiries concerning local section papers are often made, and it is apparent that FOOD TECHNOLOGY would be performing a useful service by publishing acceptable papers from these sources. Although it may not be possible to publish all papers received, every effort will be made to accommodate those that meet journal standards.

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